This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

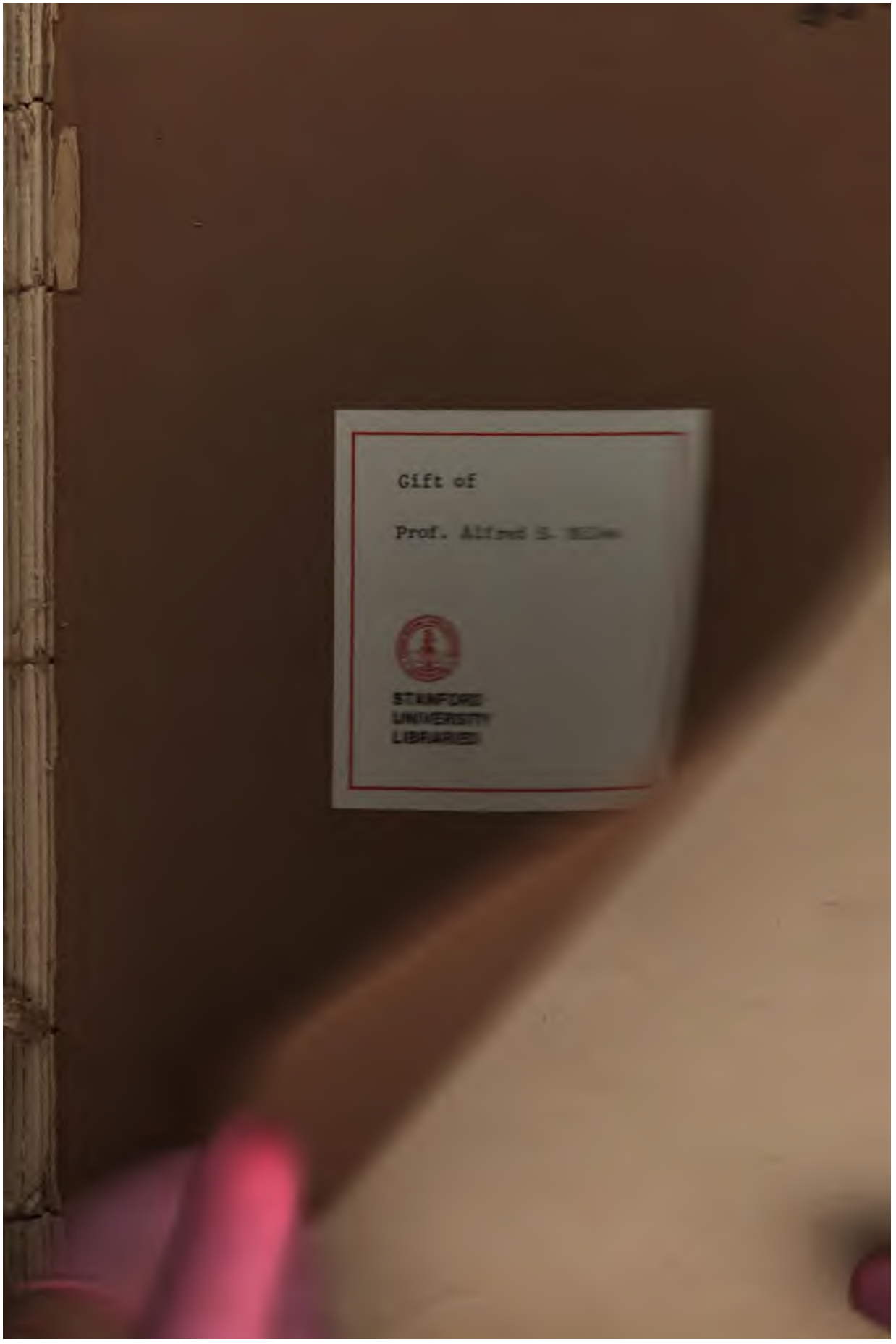
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

WITH SUPPLEMENT

PRICE $ 4.00

ALFRED S. NILES


Gift of

Prof. Alfred S. [illegible]

STANFORD
UNIVERSITY
LIBRARIES

SAWS:

THE HISTORY, DEVELOPMENT, ACTION, CLASSIFICATION, AND COMPARISON OF SAWS OF ALL KINDS,

WITH COPIOUS APPENDICES,

GIVING THE DETAILS OF MANUFACTURE, FILING, SETTING, SWAGING, GUMMING, &c.; CARE AND USE OF SAWS; TABLES OF GAUGES; CAPACITIES OF SAW MILLS; LISTS OF SAW PATENTS;

AND

OTHER VALUABLE INFORMATION.

By ROBERT GRIMSHAW,

AUTHOR OF "MODERN MILLING;" "MILLER, MILLWRIGHT, AND MILL FURNISHER," ETC.

SECOND AND GREATLY ENLARGED EDITION,
WITH SUPPLEMENT.

354 ILLUSTRATIONS.

PHILADELPHIA:
E. CLAXTON & CO.,
930 MARKET STREET.
LONDON: E. & F. N. SPON, 48 CHARING CROSS.
1882.

F
J353
C7
1882

COPYRIGHT:
ROBERT GRIMSHAW.
1882.

ERRATA, FIRST EDITION.

Page 55. After "Table of Speeds for Circular Saws," insert "to give 9420 feet per minute rim speed."

Page 84, line 9. For "light" read "high."

Page 87. Fig. 129 goes on page 81.

Page 92, line 6. For "300" read "400"; for "4500" read "6283."

Page 97, line 7. For "two dozen" read "25 dozen."

Page 111, line 13. For "holding the file firm" read "holding the saw firmly."

Page 113, second line from bottom. For "front" read "point."

Page 118, seventh line from bottom. Insert "inch" after "sixteenth."

Page 120, line 4. For "ordinary" read "machinists."

Page 126, line 22. For "hand saw" read "band saw."

INTRODUCTION.

The literature of the saw considered as a tool is very meager, although there are a few not altogether impartial treatises on wood-working machinery, by leading manufacturers and others. Since Holzappfel, in 1846, there has been nothing of importance written on the subject.* But in this work, and at that date, the band saw is dismissed with a few lines; the mulay was uninvented, or unknown; inserted tooth circular saws not dreamed of; the M-tooth shown as a curiosity, and the dimensions and working capacity of the circular and other saws, correct as they were for that date, would make the present reader smile. Saws are now much thinner, have better teeth, are of better steel, and run at double the speeds there laid down. Mr. Joshua Rose, in a lengthy article in the *Polytechnic Review*, Dec., 1876, went quite thoroughly into the action of certain kinds of saw teeth; and his intelligent articles on straightening plates were the first accurate and complete published matter on that subject. From these sources the author has drawn liberally and in some cases literally.

The writer has tried to be thorough and impartial. Naturally his personal knowledge of some makes of saws (notably in the lines of cross-cuts, hand-saws and circulars) is greater than others; some makers and users were much more liberal and detailed in giving data than others, and if their saws receive greater prominence than the others, it is not the writer's fault nor intention, and can be remedied in case a second edition be called for. There are many cases in which information was refused after repeated requests.

*Since writing the above, and after this work was partly printed, the author's colleague upon the Wood Working Machinery Jury of the Paris Exposition of 1878, Prof. Exner, of the Vienna Practical High School, has issued, in the German language, a very exhaustive treatise on Saws and Sawing Machinery (*Hand Säge und Säge Maschinen.*)

The collection of material for such a work is at once amusing and annoying. The most contradictory opinions and most impossible data are met with. In the matter of horse power, as engineers differ so largely as to the rating of boilers and engines, it is not remarkable that steam users should differ or err in their calculations. It is not common to apply dynamometers to sawing machinery; and as this book is not on sawing machinery, and as the power required differs so with the condition of the lumber and the form and sharpness of the saw teeth, etc., we may let that go for a time, and say to users of machines, "A little too much belt power is about enough."

Unless specially stated otherwise, the figures and statements in this work refer to American practice.

The author begs to acknowledge his indebtedness to the following gentlemen and firms for friendly aid in furnishing data, granting interviews and answering detailed questions in person or by letter. Those marked with an asterisk furnished engravings:

American Saw Co.*
E. Andrews.*
Anoka Lumber Mills.
Henry L. Beach.
E. M. Boynton.*
Chapin & Barber.
Curtis & Co.*
Henry Disston & Sons.*
Eau Claire Lumber Co.
W. T. Ellis.
Emerson, Smith & Co.*
J. A. Fay & Co.*
Frey, Schechler & Hoover.
Eberhard Faber.
W. W. Giles.*
R. Hoe & Co.*
J. R. Hoffman.
Lane & Bodley.*
London, Berry & Orton.*
W. C. Margedant.
A. G. McCoy.*
F. McDonough.
Wm. McNiece.*
D. B. McRae.
N. Y. Belting and Packing Co.
Nicholson File Co.*
P. Pryibil.
Richardson Bros.
Joshua Rose.*
E. Roth.
Snyder Bros.
N. W. Spaulding & Co.*
Stearns Manufacturing Co.*
Geo. Tiemann & Co.*
Trump Bros.*
Waterous Engine Works.
Wyman, Buswell & Co.

Some engravings and information arrived too late for use here, but will be used and duly acknowledged should another edition be called for.

TO MY GOOD FRIEND,

JULES ARMENGAUD,

CONSULTING ENGINEER; ANCIEN ÉLÈVE DE L'ÉCOLE POLYTECHNIQUE; SECRETARY OF THE SOCIETY OF CIVIL ENGINEERS, PARIS, &c.;

MY COLLEAGUE ON THE INTERNATIONAL JURY OF AWARDS, AT THE UNIVERSAL EXPOSITION OF 1878:

IN FRIENDLY RECOLLECTION OF OUR HARMONIOUS WORK TOGETHER, AND IN APPRECIATION OF HIS VARIED ATTAINMENTS, HIS ADMIRABLE SOCIAL QUALITIES, AND HIS WELCOME HOSPITALITY,

THIS BOOK IS DEDICATED.

INDEX.

[Illustrations marked (*). "Saw" abbreviated *s.*]

Adaptability of teeth to various work.....*12, 18
Adjustable backed s.....*34
Angle of teeth, generic.....11
Air pump s.....34, *39
Albion mill, chisel bit saw in.....72
Alphabetical list of U.S. saw patents.....154
AMERICAN SAW CO.—circular s. 72, *75, *76, *87, 153, inserted teeth, cutting action of 72, *75 perforated circ. s. *87, perforated inserted tooth circ. s.....72, *76
American gang sash machine.....face *22
Ancient Greek carpenters' s.....11
Anvil, sawmakers'.....*103
Ancient set.....*126
ANDREWS, E.—climax cross-cut *40, feather edge jig *48, gang sash *23, increment tooth mill saw *20, increment circular 59, *61, tests of his circular saw.....153
Angles of circular s. teeth *58, 59, of tooth.....11
Architecture, American, influenced by jig saw..48
Arctic saw.....43
Armstrong's spiral s.....10
Asiatic s.....11
Attachment of inserted teeth.....78
Atwist.....*106
Axes, waste in cutting with.....10

Back guide for band s.....89
Backed saws *33, lengths, gauges, fineness.....30
Baldridge, J. W. & Co., their circular s.....153
Baltic country, saws for.....82
BAND SAW 10, 83, back guide for 89, brazing of blades 141, *142 blades, strength of, 158, cutting action 87, date of first 83, economy of 86, feed 88, feeding up mill *88, files for 115, 118, for hard wood 90, for soft wood 90, friction of blades 88, gang 90, gauges of 92, guidance of 85, 88, gullets 90, heating of 85, joining blades 141, *142, kerf of 85, 92, packing of 88, rake of 90, set of 88, scroll s. *89, scroll sawing 85, scroll resaw *90, *91, superseding jig 43, tension of 85, 88, throat room 86, tires for pulleys 84
'Barber" tooth.....58
Barrel-shaped s.....10
Barrel-head s. (see *concave s.*)
Bartlett cross-cut.....*47
Bath-stone, teeth for.....*12
Bauer, C. A., circular saw tests by.....153
Belt saw (see *band s.*)
Bevel (see *cross angle.*)
Blacksmiths' s.....*112
BLADES, buck saw *49, scroll s. *48, feather edge *48
Blocking hammer.....*103
Blocking saws.....*104, 105
Blunt end file.....120, *122
Bolter, Stearns' eight saw lath.....*72
BONE, circular s. for *65, saw for 34. *35, proper teeth for.....18
Bostwick's emery gummer.....135, *139
Borax water for brazing.....141
Brass, circular s. for.....65
Brazing band s. blades.....141
BRAZING, tongs for *142, borax water for.....142
Briar teeth.....31
Britannia metal, circ. s. for.....65

Brooke movable tooth circular s.....72, *74
Bronze s.....9
Brown's inserted tooth.....*77
Boynton Brothers fast cutting.....159
BOYNTON M-tooth saws, *17, *36, *42, sawset.....*127
Brunel inv. circ. s.....53
Buckled saws.....102
BUCK SAW *50, American *51, *52, Andrews' steel spring *60, blades.....*49
Butting saw.....24, 26
Button s.....82
"BUZZ" saw (see *circular s.*)

California, sawing in.....56
Carcase s.....33
Care and use of circ. s.....105, 106, 107
Carib s.....9
CAPACITY of gang sash 22, of saw-mills and power to run them 150, of single sash.....21
Centre-bound circular.....102
CHAIN SAWS 10, Stohlmann's novel *94, Tiemann's concave cutting *92, Tiemann's convex cutting.....*93
Chamber, dust.....14, 78
Chambering (see *gumming*).
Champion cross-cut.....*45
Chapin & Barber's remarkable sawing.....77
Chatter, prevention of.....15
Chest s.....30
CHISEL-BIT circ. s. *73, duty of at the Albion Mill on West Coast.....72
Chloride of zinc, to make.....141
Cincinnati, tests of circ. s. in 1874.....17, 153

CIRCULAR SAWS, 10, 12, 53, Am. tendency to thin 59, angle at which they meet the material 57, *58, in California 56, care and use of *108, centre-bound 102, concave *67, cooling 81, for cross-cutting 57, cutting action *87, date of first 53, diameter and gauges 66, 107, mandrel holes 66, dished (*see concave*), dishing *107, double *56, dust chamber 78, economy 86, eight-toothed *53, filing and care of 59, *118, in Southern States 66, for gas burner slits 62, for general work *64, grinding 67, for gold pen slits *62, 64, guidance 54, guide lines on *70, for hard wood *64, heating of 61, for hemlock 58, in Holland 53, horizontal for shingle 54, kerf 54, largest 62, making *56, lath 57, mandrel holes 158, Millers' 53, ingot for 97, right and left handed 67, *68, for ripping *64, for screw heads 62, mode of toothing 64, for telescope makers 62, three high for redwood logs 56, throat 68, 78, for various materials 65, velocity of 55, 56, for veneers 61, *63, for weather boards *53, rim-bound 102, rim tapering 61, for pine [illegible] mental *62, size of work for 5[illegible] in world *62, speed of taper [illegible] *65, side-cutting shingle 157, *54, solid toothed 53, for scre[illegible] of 55, 56, wabbling of 54 (see *al[illegible] ture of saws; ca[illegible]e and use of c*

CIRCULAR SAW TEETH *12, action of top and bottom *58, angles of *58, 59, choice of 56, fewest number of 66, for cross-cutting *64, filing 118, gauge for 119, gumming 118, inclination 53, 57, number for wood 65, rake 57, spacing 53, set 53, varieties of *64, Andrews' increment 59, *61, Barber's 58, Gridley's 59, *60, Knowles' 59, *61 (see *also inserted teeth*) cracks in 79, 81, expansion of 79—81, perforated..... 87
Clamps for saw filing.....111, *117
Classification of s. 10, of straight s..... 20
Cleaner teeth 37, *38, gauge for.....*114
Clearer teeth (see *cleaners*)..... 37
Clemson's inserted tooth..... *77
Climax cross-cut, Andrews' *40, Disston's *41
Clogging..... 20
Close teeth..... 14
Contest, sawing at Cincinnati in 1874..... 17
Cooling circular s..... 81
Combination s.....30, *31
Comb cutters' s..... .....33, *34
Colsen's ins. tooth circ. s..... *77
COMPASS s. 30, *34, McNiece's *31, lengths, gauges and fineness of..... 30
Cone bushing, adjustable, for circ. s..... 82
"Conqueror" swage..... *129
Continuous acting s..... 10
Continuous s. (see *band, chain, circular, rotary*)
Corundum, sawing into blocks..... 157
Cost of running inserted teeth 69
Cracks, preventing.....79, *80, 81
Cross angle.....12, *16, *112, *113
Cross-cutting, Boynton's rapid..... 159
Cross-cutting teeth for circ. s..... 57
Cross-cut teeth..... *12
CROSS-CUTS *12, *32, *36, 37, *39, *40, 41, *42, *43, *44, *45, *46, *47, *64, 114, 159, blanks for 98, for wood 13, file 114, *115, gullets of 37, gumming 38, ingot for 98, object of 36, for one man *32, perforated.....40, *43, 44
Crown s..... 82
CUTTING ACTION of circ. s. *87, of band s. *87, of inserted tooth circ. s..... *75
Cutting, greatest economy in..... 57
Cut, push..... 18
Curtis & Co., their circ. s..... 153
Curvilinear s. (see *band, circ., chain, cylinder*).
Cylindrical (see *cylinder*).
Cylinder s.....10, *82, *83

"Deal frame"..... 22
Detachable back s.....33, *34
Diamond tool. Emerson's..... *14
tooth cross-cut..... *39
DIRECTIONS FOR ORDERING circ. s. 145, shingle s. 145, concave s..... 145
Dished circulars 67 (see *concave*).
Dishing saws.....*102
Doghead hammer.....*102, 103
Dom Pedro, tests before..... 159
Double cutting s. 20
cutting circ. s..... 55
edged s.....36, 49
circular mill, Lane & Bodley's..... *56
DISSTON'S cleaner gauge *114, cross-cuts *39, *40, *41, *42, enlarging circulars 81, filing machine *120, files 120, *122, inserted teeth *77, kinds of circ. s. teeth *64, saw set....*127
Double-ended files.....*121, *122, 119, 120
Dovetail s.....10, 33
Drag sawing machine Giles *29, Stearns..... *24
Drag s.....24, 26, *28
Dry lumber, causes heating..... 61
Dust chamber.....14, 78
Duty of Hoe's chisel bit..... 72

ECONOMY of band s. 86, of circular s. 86, of mulay s..... 86
Egyptian s..... 9
Eight-toothed circ..... *53

EMERSON, inserted tooth circ. 58, *77, *71, swage *130, diamond tool.....*140
Emerson, Ford & Co's circular..... 153
EMERSON, SMITH & Co., cost of running their planer toothed saws 69, swage.....*130
Emery wheels hardening saw plates..... 137
truing.....137, *140
gummer..... 134
English cross-cut..... *12
Enlarging circ. s., Disston's patent..... 81
Expansion of circulars..... 79

Faber's smallest circ. s. in the world..... *62, 64
Farmer's drag s..... 28
Fast cutting 159
FAY & Co's band scroll s. *89, mulay scroll s. *25 circ. resaw *72, reciprocating resaw *20, band resaw.. ..... *88
"Feather edge" blades..... *48
Feeds.....17, 21
FEED for circular 110, shot gun 78, of band s. 88, of ins. teeth circ. s..... 81
FILES, expense for 69, double-ender *121, *122, for hand-saw 119, *121, *122, for band saw 115, 118, gumming with 131, *132, knob end *122, lumberman's *115, machinists' *121 124 (see *Appendix III*, p. 111).
FILING saws 111, circular s. 59, *118, machines *119, *120, *123, M-teeth 19, shingle saws 118
Fine-grained woods, teeth for..... 18
Fire-wood, drag s. for..... *28
Flat pitched teeth..... 11
Flattening saws..... 100
Fleam (see *cross-angle*)
Fleetwood fret saw. *48
Flexible-bladed s..... 18
Flint s..... 9
Frame s. (see *sash saw*)..... 21
Free saw..... 20
Fret saws.....43, *48, *49
Friction of band s. blades..... 88
Front rake.....*14, 15

GANG band s. 89, sash s. 22, *23, Andrews' increment toothed s..... *23
sash, WICKES'..... .....face 22
Gate s. (see *sash s.*)..... 21
Gas-burner slits, circular for..... 62
GAUGES of band saws 92, of concave s. 67, of mulay s. 24, for measurement *143, 144, of taper and parallel s. 30, of inserted tooth s. 72
Gig s. (see *jig*).
Giles drag saw machine..... *29
Gin saw..... 158
Gold pen slits, circular s. for.....*62, 64
Greek s.....9, 11
Greeley, H., opinion of sawyers..... 157
"Great American" cross-cut.....*40, *115, *116, *117
Gridley teeth..... .....59, *60
GRINDING saws 100, circular s. 67, *107, 54, cross cuts 100
Guided s 20
GUIDANCE of band s. 85, 88, of circ. s..... 54
Guide lines for circ. s..... *70
for filing circ. s.....*123
Gulleting.....37, 131
Guilet tooth.....*113
GULLETS of band s. 90, of cross-cuts 37, perforated..... .....81, *87
GUMMING, 37, 81, 131, bad *138, with file *132, presses for *99, *133, *134, by spiral lines 132, cost of 81, cross-cuts 38, when needed *138
GUMMER, emery *134, *139, rotary.....*134
Gummy materials, teeth for..... .....18, 56

Half-moon teeth..... .....*12, 31
Half-rip..... 30
Hammers, blocking and sharpening..*102, *103, 113
HAMMERING saws..... .....102, *105, *106, *107
Hand rip saw.....20, 28, 31

Hammer setting 126
HAND-SAWS *12, *16, 112, 114, classification of 30, cutting action of *34 files for 119, *121, *122, for ice 32, filing truly *35, lengths, gauges, fineness 30, ingots for 96, teeth of *16, testing 100
Hand sawing, distribution of power 34
Hand rip 20
Handled saws 20
Hardness of inserted teeth 72
HARD WOOD, circ. s. teeth for 56, *57, band-saw for 90, teeth for 18, *64, *157, feed for 21
Hardening saw plates 100
HEATING of bands 85, of circ. s 79, 61, 80
Heavy saws *15
Hemlock, teeth for 17, 58
HOE & Co's circular saws 72, *73, 153, inserted tooth *77, mill s. tooth *21
Hogan & Snowden, test of their circ. s 153
Holland, circ. s. in 53
Honing 114
Hook 118
Horizontal circ. s. for shingles 56
Humphrey's inserted tooth *77

Ice saws 18, 32, 43
Inches graduated to centimetres 144
Inclination of teeth of circular s 57, 53
INCREMENT TEETH 22, 23, *20, 28, 34, 59, Andrews' gang sash *23, gang sash *23
INGOTS 96, for cross-cuts *98, for circular *97
Inventor of saw 9
Iron, circ. s. for 65
INSERTED TEETH (see under *circ. s.*), date of 72, action of 72, advantages of 67, attachment of 78, Am. Saw Co's 72, *76, Brooke's 72, chisel bit *73, cost of running 69, date of first 72, Emerson's 58, duty of Hoe's 72, for New Zealand or Canada 69, gauges of 72, hardness of 72, kerf by 72, perforated 72, *76, rectangular sockets 72, remarkable sawing by 77, sawing by 69, spacing 79, Spaulding's 81, wear of *71, weight of 72, on west coast 72, various *77
Italian wood sawyer 157
IVORY, circular s. for 65, teeth for 18

Japanese s *17, 18
Jig 24, 43
Jig s., influence of 48
Joining band saw blades *141, 142
Joiners' s *12
Jones tooth 108, *110
Jumping (see *swaging*).

Kellogg, Sawyer & Co output 158
KERF of band s. 85, 92, of circ. s 54, 57, of inserted teeth 72
Keyhole saws *17, 18, 19, 30, 31
Keystone saw works 95
cross-cut *39
Knob-end files *122
Knots 17, to cut through 114
Knowles' circ. s. tooth 59, *61
Krauser's inserted tooth *77

Lane & Bodley's side guide for circ. s *54
double circ. mill *56
LATH machine 57, Stearns' 24
Lath bolter, Stearns' eight saw *72
Lightning cross-cut teeth *19, 159
Link s (see *chain*).
Lippincott's inserted tooth *77
Littlepage's planer bit circ. s *79
Loaf sugar circ. s 65
Lock s 31
Lockwood's slotted circ. s 79, *80
Logs for mulay 24
Loose places 105, *106
LUMBERMAN'S cross-cut file *39, clipper, remarkable sawing by 77, file 114, *115
Lumber measurements, table of 147
Machinists' files 124
Mahogany, teeth for 62
Mandrel holes for circ. s 158, 166
Manufacture of saws ..... *95 *et seq.*
McCoy, A. G., remarkable sawing by 77
McNiece's compass saw 31
Measurements of logs, tables for 145
Metal-saw teeth *12, 18, 65, *112
Mexican s 9
Microscope rack s 34, *39
Milling cutter for gumming 131, *135
MILL SAW, Hoe's tooth *12, *18, 19, *20, *21, *112
Miller's inserted tooth circ. s 53, *77
Miter s 30, *33
Moist material, teeth for 56
Movable teeth (see *inserted teeth*) *17, *18, *19
M TEETH *17, *18, 19, of 1846 50, *12, 35, *36, *112, twin clipper 37
Mühlsäge (see *mulay*).
MULAY SAW 20, 22, 24, 25, economy of 86
Muley s. (see *mulay*).
Muriate of zinc (see *zinc*) 141

Neale's inserted tooth *77
Newberry, Wm., original band s 83, *84, *85
Niphonese s 18

Obsidian s 9
Ohlen, James, trial of his circ. s 153
Oldham's rules for ordering ingots 96
One man cross-cut s *32
Ordering saws, directions for 145
Original saw 9
band s. of Wm. Newberry *83, *84, *85
Output 158
Oversetting 17
Overhang, Andrews' mode of giving 22

Packing of band s teeth 88
Panel s., lengths, gauges, fineness 30
Parallel s., lengths, gauges, fineness 30, 33
teeth *114
Peg tooth *13, *12, *112
Perdrix 9
PERFORATED circular s. 72, 81, *87, cross-cut 40, *43, *44, 46, 47, gullets *87, inserted tooth for circular s *76
Perin, father of the band s. 92, test of band s. blades 158
Peripheral tooth line for circ. s 97, *99
Pine, teeth for 58
PIT SAW 36, teeth for *12, sharpening 113
Pitch of tooth 11
"Planer bits" 68, *71
Planer bit circ. s., Littlepage's *79
"Plows" (see *cleaners*) 37
Points 11
Polishing circ. s 101
POWER REQUIRED for 10,000 feet of lumber a day 152, for band resaw 152, for band scroll s. 151, for 60-inch circ. through a hemlock log 152, for drag butting 151, for gang sash s. 150, for jig s. 151, for mulay s 151, for single circ. s. 152, for single sash 150
Press for gumming 131, *133, 134
Premium cross-cut *46
Proud edge 118
Pruning s 31, *32, *36, *37, *113
hook attachment *32
teeth *12
Pryibil's uphill feed band s *88
Pull cut s 11, 20
Push cut 11, 18
Punch (see *press*)

Rack-cutting s 34
Rakes of teeth *14, 53, *57, *89
Ransome's tree-feller 24, *27
Rehammered circulars 137
Reciprocating s 10, 11, 20

CIRCULAR SAW TEETH *12, action of top and bottom *58, angles of *58, 59, choice of 56, fewest number of 66, for cross-cutting *64, filing 118, gauge for 119, gumming 118, inclination 53, 57, number for wood 65, rake 57, spacing 53, set 53, varieties of *64, Andrews' increment 59, *61, Barber's 58, Gridley's 59, *60, Knowles' 59, *61 (see *also inserted teeth*) cracks in 79, 81, expansion of 79—81, perforated..... 87
Clamps for saw filing.....111, *117
Classification of s. 10, of straight s..... 20
Cleaner teeth 37, *38, gauge for.....*114
Clearer teeth (see *cleaners*)..... 37
Clemson's inserted tooth..... *77
Climax cross-cut, Andrews' *40, Disston's *41
Clogging..... 20
Close teeth..... 14
Contest, sawing at Cincinnati in 1874..... 17
Cooling circular s..... 81
Combination s.....30, *31
Comb cutters' s.....33, *34
Colsen's ins. tooth circ. s..... *77
COMPASS s. 30, *34, McNiece's *31, lengths, gauges and fineness of..... 30
Cone bushing, adjustable, for circ. s..... 82
"Conqueror" swage..... .....*129
Continuous acting s..... 10
Continuous s. (see *band, chain, circular, rotary*)
Corundum, sawing into blocks..... 157
Cost of running inserted teeth 69
Cracks, preventing.....79, *80, 81
Cross angle.....12, *16, *112, *113
Cross-cutting, Boynton's rapid..... 159
Cross-cutting teeth for circ. s..... 57
Cross-cut teeth..... *12
CROSS-CUTS *12, *32, *36, 37, *39, *40, 41, *42, *43, *44, *45, *46, *47, *64, 114, 159, blanks for 98, for wood 13, file 114, *115, gullets of 37, gumming 38, ingot for 98, object of 36, for one man *32, perforated.....40, *43, 44
Crown s..... 82
CUTTING ACTION of circ. s. *87, of band s. *87, of inserted tooth circ. s..... *75
Cutting, greatest economy in..... 57
Cut, push..... 18
Curtis & Co., their circ. s..... 153
Curvilinear s. (see *band, circ., chain, cylinder*).
Cylindrical (see *cylinder*).
Cylinder s.....10, *82, *83

"Deal frame"..... 22
Detachable back s.....33, *34
Diamond tool, Emerson's..... *14
tooth cross-cut..... *39
DIRECTIONS FOR ORDERING circ. s. 145, shingle s. 145, concave s..... 145
Dished circulars 67 (see *concave*).
Dishing saws.....*102
Doghead hammer..... .....*102, 103
Dom Pedro, tests before..... 159
Double cutting s. 20
cutting circ. s..... 55
edged s.....36, 49
circular mill, Lane & Bodley's..... *56
DISSTON'S cleaner gauge *114, cross-cuts *39, *40, *41, *42, enlarging circulars 81, filing machine *120, files 120, *122, inserted teeth *77, kinds of circ. s. teeth *64, saw set....*127
Double-ended files.....*121, *122, 119, 120
Dovetail s..... .....10, 33
Drag sawing machine, Giles *29, Stearns..... *24
Drag s.....24, 26, *28
Dry lumber, causes heating..... 61
Dust chamber.....14, 78
Duty of Hoe's chisel bit..... 72

ECONOMY of band s. 86, of circular s. 86, of mulay s..... 86
Egyptian s..... 9
Eight-toothed circ..... *53

EMERSON, inserted tooth circ. 58, *77, *71, swage *130, diamond tool.....*140
Emerson, Ford & Co's circular..... 153
EMERSON, SMITH & Co., cost of running their planer toothed saws 69, swage..... .....*130
Emery wheels hardening saw plates..... 137
truing.....137, *140
gummer..... 134
English cross-cut..... *12
Enlarging circ. s., Disston's patent..... 81
Expansion of circulars..... 79

Faber's smallest circ. s. in the world..... *62, 64
Farmer's drag s..... 28
Fast cutting 159
FAY & Co's band scroll s. *89, mulay scroll s. *25 circ. resaw *72, reciprocating resaw *20, band resaw.. ..... *88
"Feather edge" blades..... *48
Feeds.....17, 21
FEED for circular 110, shot gun 78, of band s. 88, of ins. teeth circ. s..... 81
FILES, expense for 69, double-ender *121, *122, for hand-saw 119, *121, *122, for band saw 115, 118, gumming with 131, *132, knob end *122, lumberman's *115, machinists' *121 124 (see *Appendix III*, p. 111).
FILING saws 111, circular s. 59, *118, machines *119, *120, *123, M-teeth 19, shingle saws 118
Fine-grained woods, teeth for..... 18
Fire-wood, drag s. for..... *28
Flat pitched teeth..... 11
Flattening saws..... 100
Fleam (see *cross-angle*)
Fleetwood fret saw. *48
Flexible-bladed s. 18
Flint s..... 9
Frame s. (see *sash saw*)..... 21
Free saw..... 20
Fret saws.....43, *48, *49
Friction of band s. blades..... 88
Front rake.....*14, 15

GANG band s. 89, sash s. 22, *23, Andrews' increment toothed s..... *23
sash, Wickes'..... .....face 22
Gate s. (see *sash s.*)..... 21
Gas-burner slits, circular for..... 62
GAUGES of band saws 92, of concave s. 67, of mulay s. 24, for measurement *143, 144, of taper and parallel s. 30, of inserted tooth s. 72
Gig s. (see *jig*).
Giles drag saw machine..... .. *29
Gin saw..... 158
Gold pen slits, circular s. for.....*62, 64
Greek s.....9, 11
Greeley, H., opinion of sawyers..... 157
"Great American" cross-cut.....*40, *115, *116, *117
Gridley teeth..... .....59, *60
GRINDING saws 100, circular s. 67, *107, 54, cross cuts 100
Guided s 20
GUIDANCE of band s. 85, 88, of circ. s..... 54
Guide lines for circ. s..... *70
for filing circ. s.....*123
Gulleting.....37, 131
Gullet tooth.....*113
GULLETS of band s. 90, of cross-cuts 37, perforated..... .....81, *87
GUMMING, 37, 81, 131, bad *138, with file *132, presses for *99, *133, *134, by spiral lines 132, cost of 81, cross-cuts 38, when needed *138
GUMMER, emery *134, *139, rotary.....*134
Gummy materials, teeth for..... .....18, 56

Half-moon teeth..... .....*12, 31
Half-rip..... 30
Hammers, blocking and sharpening..*102, *103, 113
HAMMERING saws..... .....102, *105, *106, *107
Hand rip saw.....20, 28, 31

Hammer setting 126
HAND-SAWS *12, *16, 112, 114, classification of 30, cutting action of *34 files for 119, *121, *122, for ice 32, filing truly *35, lengths, gauges, fineness 30, ingots for 96, teeth of *16, testing 100
Hand sawing, distribution of power 34
Hand rip 20
Handled saws 20
Hardness of inserted teeth 72
HARD WOOD, circ. s. teeth for 56, *57, band-saw for 90, teeth for 18, *64, *157, feed for 21
Hardening saw plates 100
HEATING of bands 85, of circ. s 79, 61, 80
Heavy saws *15
Hemlock, teeth for 17, 58
HOE & Co's circular saws 72, *73, 153, inserted tooth *77, mill s. tooth *21
Hogan & Snowden, test of their circ. s 153
Holland, circ. s. in 53
Honing 114
Hook 118
Horizontal circ. s. for shingles 56
Humphrey's inserted tooth *77

Ice saws 18, 32, 43
Inches graduated to centimetres 144
Inclination of teeth of circular s 57, 53
INCREMENT TEETH 22, 23, *20, 28, 34, 59, Andrews' gang sash *23, gang sash *23
INGOTS 96, for cross-cuts *98, for circular *97
Inventor of saw 9
Iron, circ. s. for 65
INSERTED TEETH (see under *circ. s.*), date of 72, action of 72, advantages of 67, attachment of 78, Am. Saw Co's 72, *76, Brooke's 72, chisel bit *73, cost of running 69, date of first 72, Emerson's 58, duty of Hoe's 72, for New Zealand or Canada 69, gauges of 72, hardness of 72, kerf by 72, perforated 72, *76, rectangular sockets 72, remarkable sawing by 77, sawing by 69, spacing 79, Spaulding's 81, wear of *71, weight of 72, on west coast 72, various *77
Italian wood sawyer 157
IVORY, circular s. for 65, teeth for 18

Japanese s *17, 18
Jig 24, 43
Jig s., influence of 48
Joining band saw blades *141, 142
Joiners' s *12
Jones tooth 108, *110
Jumping (see *swaging*).

Kellogg, Sawyer & Co output 158
KERF of band s. 85, 92, of circ. s 54, 57, of inserted teeth 72
Keyhole saws *17, 18, 19, 30, 31
Keystone saw works 95
cross-cut *39
Knob-end files *122
Knots 17, to cut through 114
Knowles' circ. s. tooth 59, *61
Krauser's inserted tooth *77

Lane & Bodley's side guide for circ. s *54
double circ. mill *56
LATH machine 57, Stearns' 24
Lath bolter, Stearns' eight saw *72
Lightning cross-cut teeth *19, 159
Link s (see *chain*).
Lippincott's inserted tooth *77
Littlepage's planer bit circ. s *79
Loaf sugar circ. s 65
Lock s 31
Lockwood's slotted circ. s 79, *80
Logs for mulay 24
Loose places 105, *106
LUMBERMAN'S cross-cut file *39, clipper, remarkable sawing by 77, file 114, *115

Lumber measurements, table of 147
Machinists' files 124
Mahogany, teeth for 62
Mandrel holes for circ. s 158, 166
Manufacture of saws ..... *95 *et seq.*
McCoy, A. G., remarkable sawing by 77
McNiece's compass saw 31
Measurements of logs, tables for 145
Metal-saw teeth *12, 18, 65, *112
Mexican s 9
Microscope rack s 34, *39
Milling cutter for gumming 131, *135
MILL SAW, Hoe's tooth *12, *18, 19, *20, *21, *112
Miller's inserted tooth circ. s 53, *77
Miter s 30, *33
Moist material, teeth for 56
Movable teeth (see *inserted teeth*) *17, *18, *19
M TEETH *17, *18, 19, of 1846 50, *12, 35, *36, *112, twin clipper 37
Mühlsäge (see *mulay*).
MULAY SAW 20, 22, 24, 25, economy of 86
Muley s. (see *mulay*).
Muriate of zinc (see *zinc*) 141

Neale's inserted tooth *77
Newberry, Wm., original band s 83, *84*, 85
Niphonese s 18

Obsidian s 9
Ohlen, James, trial of his circ. s 153
Oldham's rules for ordering ingots 96
One man cross-cut s *32
Ordering saws, directions for 145
Original saw 9
band s. of Wm. Newberry *83, *84, *85
Output 158
Oversetting 17
Overhang, Andrews' mode of giving 22

Packing of band s. teeth 88
Panel s., lengths, gauges, fineness 30
Parallel s., lengths, gauges, fineness 30, 33
teeth *114
Peg tooth *13, *12, *112
Perdrix 9
PERFORATED circular s. 72, 81, *87, cross-cut 40, *43, *44, 46, 47, gullets *87, inserted tooth for circular s *76
Perin, father of the band s. 92, test of band s. blades 158
Peripheral tooth line for circ. s 97, *99
Pine, teeth for 58
PIT SAW 36, teeth for *12, sharpening 113
Pitch of tooth 11
"Planer bits" 68, *71
Planer bit circ. s., Littlepage's *79
"Plows" (see *cleaners*) 37
Points 11
Polishing circ. s 101
POWER REQUIRED for 10,000 feet of lumber a day 152, for band resaw 152, for band scroll s. 151, for 60-inch circ. through a hemlock log 152, for drag butting 151, for gang sash s. 150, for jig s. 151, for mulay s 151, for single circ. s. 152, for single sash 150
Press for gumming 131, *133, 134
Premium cross-cut *46
Proud edge 118
Pruning s 31, *32, *36, *37, *113
hook attachment *32
teeth *12
Pryibil's uphill feed band s *88
Pull cut s 11, 20
Push cut 11, 18
Punch (see *press*)

Rack-cutting s 34
Rakes of teeth *14, 53, *57, *89
Ransome's tree-feller 24, *27
Rehammered circulars 137
Reciprocating s 10, 11, 20

Red-wood logs, circ. for..... 56
Remarkable sawing of A. G. McCoy..... 77
Removable teeth (see *inserted teeth*).
Resawing squared logs..... 22
machine, Fay's circ. *72, Fay's reciprocating *20, Fay's band..... *88
Resinous material..... 56
materials, teeth for..... 18
Reversible file (see *double-ender*).
Ribbon s. (see *band s.*)
Richards, London & Kelly, band s. tests..... 158
Richards, speed of circ. s..... 55
Right- and left-handed circ. s..... 67, *68
Rim-bound circ. s..... 102
Ripping s..... *64, *12, 13, 57
Rip s., length, gauges, fineness..... 30, *31
Robinson's veneer saw..... 36
Rose-wood, teeth for..... 62
Rose, Joshua, illustrations of saw straightening *102 to *107
Rossing machine, Stearns'. *72
Rotary s. (see *circular*).
gummer..... *134
Rotating s. (see *circular*).
Roth's saw file guide *123
Round s..... 50
Router's s., double edged..... 49
Rules to find the number of boards a log will produce..... 146—147
Running into or out of log..... 80

Sash saw 20, 33, single, capacity of 21, gang 22, *23
Saving of lumber by thin saws..... 59
Sawdust, discharge of 78 (see *clogging, throat room*).
Saw filing (Appendix III p. 111).
Sawing, curved 30, feat..... 77
Saw patents, alphabetical list of 154
Saw making (appendix) 95, plates, Oldham's rule for 96, sets *127, swage *129, works, largest in the world..... 95
Scarf (see *kerf*).
Scientific use of s..... 10
Scoring teeth..... 37
Scroll saw 24, *25, 43, mulay 24, blades for *48, *49
Scroll sawing with bands 85
Screw heads, circular s. for 62, screw head..... 33
Segmental circulars..... *63, *62, 81
Set, ancient *126, of band s. 88, modern *126, of teeth of circular s..... *53, 59
Setting *15, even, over 17, spring sets..... *16, *125
Sharpening (see *filing*).
Shell s 6
Shingles, tables of 159, bolts, drag saw for..... 28
Shingle machine, largest in the world..... 56
saws, regrinding necessary, 56, filing 118, taper of 55, speed of Simond's... 56
Ship timber, cutting by hand s..... 85
Shoemaker's inserted tooth..... *77
Short teeth..... 14
Shot-gun feed for cir. s..... 78
Side guide (Lane & Bodley) *54, angle *16, file *119
Simond's saws, steam feed..... 118
Single cutting s. 20, sash s..... 20, 22
Surgical circular s..... *65
Skip tooth..... *12
Skins' saws for..... 83
"Skew back" rip s..... *31
Slitting s. (see *ripping*).
Slotted saw, Lockwood's.. ..... 79, *80
Smithing saws..... 100
Smith's screw-head saws..... 33
Sockets of inserted teeth..... 72
Soft grained wood, teeth for..... 16, 18
Soft wood, bands for 90, cir. saw teeth for *57, feed for *21, teeth for..... *12, 13, 18, *157
Soldering (see *brazing*).
Solid toothed circ..... 53
Southern States, circular s. in..... 66
South sea s..... 9
Spacing of inserted teeth 70, of teeth for circular 53
Rectilinear s..... 20
Spaulding's inserted tooth for circ. s. *77, *81, rule for throat room 81
Speed of circ. s. for various materials..... 55, 65
Spikes cutting off..... 56
Spiral line gumming 132, saw..... 10
Splintering 20
Speed of circular..... 55
Spread set for mulay 24, of teeth of shingle s. 55, set..... *15, 18
Springing of teeth into work..... 15, 37
Spring set *16, 17, 18, 125, strained s..... 20, 43
Spruce, teeth for..... 17, 58
Squared logs, resawing of..... 22
"Stadda"..... 33, *34
Stave s..... 82
Steam feed..... *78
Stearns' rossing machine *72, lath bolter drag sawing machine *24
Steel for saws..... 65, 95
Stiffened backed saw..... 33
Stone age saw..... 9
Stohlmann's novel chain s..... *94
Straight saw, classification of 20, taper hand-saw..... *28
Straightening saws...102, *103, 104, *105, *106, *107
Strange's inserted tooth..... *77
Straining rods for buck s. frames..... *50
Strength of band s. blades..... 158
Surgical saws..... *65, *92, *93, *94
Sugar loaf, s. for..... 65
Swages (see appendix)..... 1..8
Swaging *16, 128, even..... 17
Swage, Emerson's... ..... *130
Swedging (see *swaging*).
Sweet, J. E., band saw tests..... 158

Table s..... 30
Tables of lumber measurements 159, of shingles 159, of measurement of logs 146, 147, *148, 149.
Taper, curved, 30, of saws 101, of shingle saws 55
Taper saw, handles of, Andrews, *30, lengths, gauges, fineness..... 30
Taylor cross-cut *39
Talus 9
Telescopes slits, circ. for..... 62
Tenon s. *33, length, gauges, fineness..... 30
Tension of bands 85, of band s..... 88
Testing hand-saws..... 100
Teeth, adaptability to various work *12, 18, 65, angle of 11, *16, 17, 18, 53, briar 31, circular *12, 14, 20, 37, *57, *64, 65, 66, cleaner or clearer 37, clogging 20, close 14, condition of 71, cross-cutting 57, cross-cut 12, 13, 57, *64, farmers' 28, fire-wood *28, flat pitched 11, fine grained wood 18, gauge for circulars *119, gullet *113, half moon *12, 31, hook *42, hand-saw *16, increment *20, 28, 34, inserted 67 *et seq.* 78, lengths of 13, 14, lightning 18, *19, mill saw, *12, 21, peg *12, *13, perforated ins. 72, pitch of 11, plows 37, pruning 12, rakes of *14, 15, 57, 89, ripping 57, setting *15, 17, springing 15, 37, for shingles 28, swaging *15, 16, 18, *28, upright V- 11, *13, various kinds 12, 13, for all the various materials 18, 50, 56, *57, *58, *64, 65, *157, wavy cutting 38, band saw teeth, gullets of 90, set 88, amount of set for curves 89, for hard wood 90, for soft wood 90, pitch of..... 89
Temper for s..... 100
Tests of band saw blades 158, of circular s. at Cincinnati, 1874, 153, before Dom Pedro.. 159
Thickness of mulay 24, of circ. s. 64
Thin teeth of circ. s..... 59
Throat or throat room *14, 53, 68, 78, Spaulding's rule 81, of band s..... 86
Thrust cut (see *push cut*).

TIEMANN'S CHAIN SAW concave cutting *93, convex cutting *92
Tight places *106
Tilghman's corundum sawing 157
TIMBER crop of America 10, value of 10, waste of *157
Time saved by inserted teeth 68
Tires for band saw machines 84
Toothing saws 97
Tongs for brazing *142
Tree-feller, Ransome's 21, *27
Trepan s *82
Trephine s *82
Truing of emery wheel 137
Trump Bros. fret saws *49
Tub s 82
Tube s 82
Tuttle cross-cut 40, *43
Twin clipper cross-cut 37. *38

Undercut teeth, filing 114
Unguided s 20
Universal s *36
Upsetting (see *swaging*).

VELOCITY of mulay, 24, of circular s 55, 56
VENEER s., Robinson's horizontal 36, cutting 61, *62, *63.
Victor fret saw *49
V tooth 13

Wabbling of circular s 53, 79
WASTE in cutting with axes 10, of timber *155
Wavy cutting 38, 54
Wear of ins. teeth *71
Web saw 50
Weatheboard circ *53
WEIGHT of inserted teeth 72, strained s 20, 43
Wet wood, teeth for 18
White metal, circular for 65
Wickes' gang sash ..... face 22
Wire edge 114
WOOD, cross-cut 13, number of circular s. teeth for 65, saw (see *buck s*) *50
Woodrough's inserted tooth *77
& M. Parlin's circ. s 153
Wrought iron, circ. s. for 65
W teeth 19
Wyman, Buswell & Co's steam feed 158

Zinc, chloride or muriate of 141

SAWS.

[The present paper will not consider in detail the question of *sawing machines*, but will be devoted to the implement itself, the blade or saw proper. Sawing machines will be thoroughly considered in the writer's forthcoming work on Wood-Working Machinery.]

The saw is one of the most ancient, useful and familiar of tools. The generic term applied to a serrated dividing tool is generally understood as applying to a saw for wood, although the implement is used also for bone, stone, metal, ice, etc.* (There is also a familiar limitation to a reciprocating hand tool). The ancient Egyptians, far back in the silent centuries, knew and used this tool, the material being bronze, hardened by an art now lost. The Greeks, masters of many and far-sailing wooden ships for war and exploration, deified the inventor, who comes down to us as Talus or Perdrix. The original saw was, doubtless, a flat notched or jagged piece of metal like a nicked knife blade, having no special form of teeth, but used with a straight reciprocating stroke, and for either ripping or cross cutting. It cut on both strokes. The saws of the stone age had flakes of flint imbedded in a wooden blade and held by means of bitumen. The Mexicans used obsidian for saw teeth. The South Sea Islanders employ sharks' teeth, and the Caribs use notched shells.

* Stone sawing, in the ordinary sense of the word, is not sawing, but abrasion in a narrow line by means of loose sand or iron shot, pressed in by a reciprocating blade, while it is also accomplished by diamonds set in iron blades. So-called "saws" for india-rubber and some of those for cold iron rails are plain unserrated disks, no more to be considered under the head of saws proper than Miss Edgeworth's essay on Irish Bulls among works on Natural History.

The saw is mostly used for converting wood and other materials from original forms, and naturally precedes the plane and other tools, although it follows the ax. It does its work with considerable speed and accuracy. In some elaborate and highly ornamental arts it is nearly the only tool used.

The importance of scientific and economical timber-cutting may be conceded when it is asserted that the annual value of the wood, lumber and timber crop of America is a billion dollars ($1,000,000,000), or four times that of our wheat crop. The immense waste in cutting timber, with the millions of axes now in use, is almost incredible. The tough and knotty timber and chips now wasted in cutting cord wood might be saved by cross cutting with saws into short blocks, say one foot long, making good stove wood.

It is computed that the saving of timber and time by the scientific use of saws would equal the interest of the United States public debt; to say nothing of lightening the toil of millions of farmers.

As we now know the saw it is either RECIPROCATING or CONTINUOUS in action; the first class having a flat blade and practically *straight edge* and making a plane cut; and the latter being either

(1) a *circular rotating disk*, cutting in a plane and at a right angle to its axis;

(2) *cylindrical*, or barrel-shaped, with a convex edge, cutting parallel to its axis; or

(3) a continuous ribbon or *band*, running on two pulleys and making a plane or curved cut, with a straight edge, parallel to their axes of rotation.

There is a fourth class, or *spiral* saw, composed of segments clamped between plates, and cutting a dovetail joint (Armstrong's patent). The entering segments cut like a circular saw; subsequent segments are flanged—at first slightly, and gradually more and more; these later segments have the cut of a cylinder saw. As the flange wears away by filing, the segments are moved on towards the unflanged end of the spiral.

Between the *Reciprocating Rectilinear* and the *Continuous-acting Curvilinear* saws may be classed the *Chain Saw;* its many varieties having either one or two axes, at right angles to the plane of cut; cutting with either a concave, a convex, or a straight edge, and either reciprocating or continuous in action. It is essentially a saw com-

posed of *links* like a chain, and is a connecting link between the two other classes.

We shall consider these classes in sequence, after having gone into the theory of the shape, disposition and action of saw teeth, as applied to the earliest, simplest and most common class, that with reciprocating rectilinear blade.

The blade of this kind of saw is usually a thin sheet of steel, rolled evenly thick, having the teeth then cut out with a punch; the blade then smithed or pressed perfectly plane or flat; ground, principally crosswise, to perfect the surface and reduce the thickness at the back; the teeth then sharpened and set.

This class of saw has more forms of teeth than any of the others. Its teeth are formed at greatly varying angles and made to cut either way or both ways; sometimes one series of teeth cuts in one direction and another in the opposite on the same blade. In the first case the effective or cutting stroke is either by pulling or by pushing. The carpenter's saw of the ancient Greeks was a straight frame, with perpendicular teeth, and two-handed—doubtless cutting both ways.

The saws of all Asia do not, and those of ancient Greece did not, employ the *thrust* cut, which gives the straightest cut and the freest from sawdust; but cut on the *back* or pulling stroke. But we shall refer to this subject later on, and consider now the outline of the teeth.

It is necessary to premise that the *pitch* of a tooth means the *angle* of the face up which the shaving ascends; not an *interval*, as with screw threads. Small teeth are counted in *points* to the inch; those of large saws by the space expressed in *inches* or in parts of an inch.

The real angle of a point is found by subtracting its back angle from its front.

The generic angle of saw teeth is 60°; being that of an equilateral or "three-square" file. But this may be variously placed. Thus, in Fig. 1 D is upright, having no pitch; G is flat, having plenty.

In the annexed table of angles and spaces the pitches are classified 15° asunder.

TABLE I.

	Simple forms of saw teeth, from Holzapffel.		Angles. Face.	Angles. Back.	Ordinary spaces. Inches.	
A		Peg; fleam.	110°	70°	⅛—1¼	
B		Plain M.	90°	30°	1—1¼	
C		Half Moon.	90°	35°	1—1¼	
D		"Cross-cut"—no pitch.	120°	60°	⅛—1¼	
E		Small cross-cut—slight pitch.	105°	45°	⅜—1	Also 3 to 60 points.
F		Pruning; ordinary pitch hand-saw; joiners; English cross-cut.	90°	30°	⅜—1	
G		Metal; mill saw—soft wood.	75°	15°	¼—2½	
H		Some circular saws—pit; cross-cut; bath stone.	75°	30°	⅛—1¼	
I		Mill.	90°	50°	⅜—4	*
J		Circular.	60°	15°	⅛—2	
K		Hard wood cross cut.	90°	30°	⅜—3½	
L		Pit; circular.	75°	20°	⅜—3½	
M		Pit; circular.	60°	10°	⅜—3½	
N		Soft wood; ripping.	45°	5°	⅜—3½	

Gullet or briar tooth.

* Sometimes each alternate tooth is cut out; then it is "skip-tooth."

The peg tooth, Fig. 2, has rather more throat room than a ⋁ tooth (Fig. 3) of ths same width and height, and less than if it were cut deeper, as by the dotted lines, Fig. 4. Being generally more acute than 60° it could not be dressed with either a three-square or a flat file if in ⋁ shape; as it is, a flat or "mill" file dresses it admirably.

Fig. 2. Peg Tooth.

Fig. 3. V Tooth.

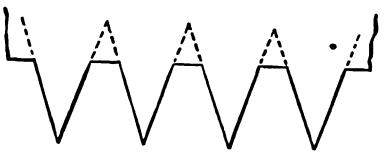


Fig. 4. Peg Tooth.

A saw tooth has two functions—*paring* and *scraping*. A *slitting or ripping* saw for wood has the cutting edge about at a right angle to the fiber of the wood, severing it in one place; the "throat" of the tooth wedging out the piece.

In a "*cross-cut*" *wood-saw*, also, the cutting edge strikes the fibre at right angles to its length, but severs it on *each side* from the main body, before dislodging it.

In the slitting saw, N, Fig. 1, the "rake" is all in front, where the cutting duty is. In the cross cut, as D, the rake is on the side, for the same reason.

The *length of tooth* depends largely upon the duty required. A long tooth has the demerit of being weak and liable to spring; the merit of giving greater clearance to the sawdust—a specially valuable feature

in soft, wet or fibrous woods. It is certain that the throat space in front of each tooth must be sufficient to contain the dust of that tooth from one stroke. If (as in a short tooth) the space be not high enough, that quality can be gained by distance between the teeth. For hard

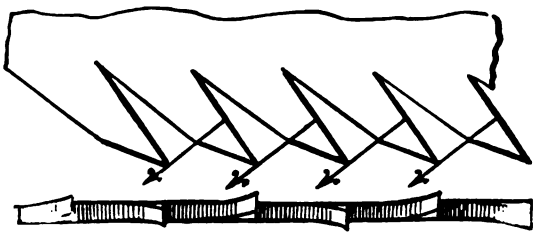


Fig. 5. Great Front Rake.

woods, where long teeth are inadmissible, it is best to have short teeth, wide spaced. The deeper the tooth the quicker the saw wears out.

The greater the feed the deeper the dust chamber required, or else the more teeth needed.

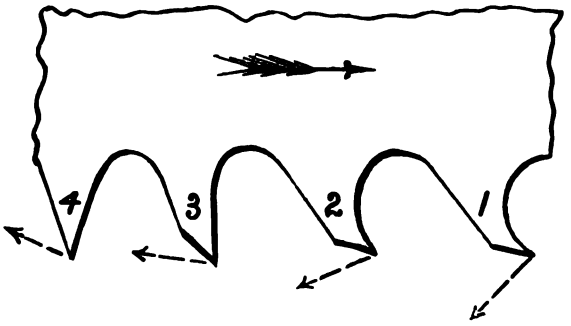


Fig. 6. Showing Various Rakes of Teeth.

Equal length of teeth is of great importance; as inequality gives the longest teeth the most work and lessens the duty of the saw; giving fewer cutting teeth and dulling them quicker.

Where the teeth are close, the shape of the throat is of special influence.

As regards the tendency of teeth to spring into the work: A form such as Fig. 5, having great front rake, is keen but liable to spring in and break, especially if long and in hard wood. In Fig. 6, tooth 1 has maximum front and minimum back rake. 2 has less hook but more back rake, tending to spring the point down into the wood. 3

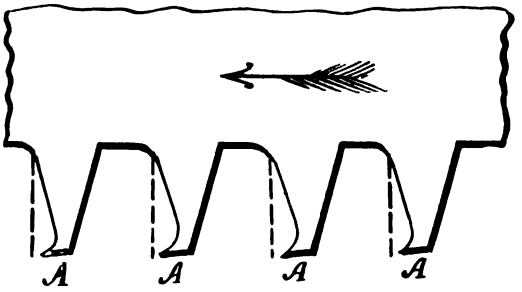


Fig. 7.

has no front rake but considerable back; in 4 the front rake is less than nothing and the keenness is largely dependent on the back edge.

Fig. 7 is recommended for heavy saws for general purposes.

This has a rake to the front of the point, and yet the tendency to spring in is compensated by the backward inclination of the whole tooth; and the cutting edge is well supported. There is ample dust

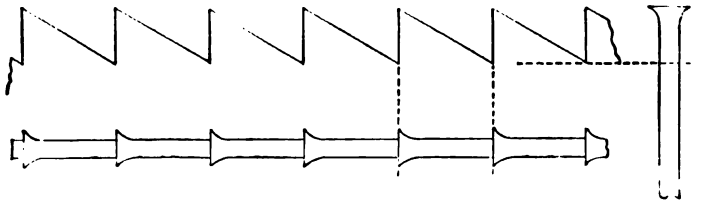


Fig. 8. Spread Set.

room; the rounding corners give strength and immunity from cracking and prevent dust lodging. The backward inclination (as in a planer tool) prevents spring or chatter.

We may now consider briefly the question of *Setting*, or bending the teeth laterally, alternately to the right and left; partly with a view to decreasing friction and increasing clearance, and partly to increase

the cutting action of the teeth, and make them *cut* rather than *abrade.* (The earlier nations bent the points of a dozen or so of adjacent teeth to one side, and those of the next group to the other.)

"*Swaging,*" is another operation having the same objects—giving clearance, preventing binding and heating, and giving increased keenness to the teeth. In this operation each tooth is upset or widened at its point so as to project beyond the blade at each side; differing in this respect from spring setting. See Fig. 8.

Swaging or upsetting is especially beneficial for soft steels and for saws used in soft wood, as it condenses and hardens the metal.

In connection with spring set must be mentioned *side or cross angle;* a bevel or "fleam" given the edges and materially affecting

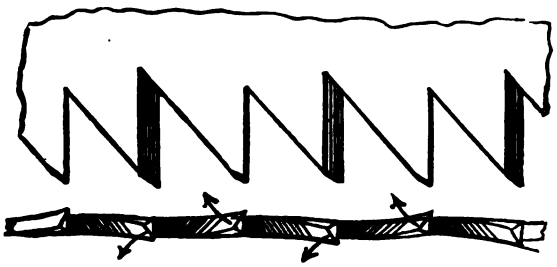


Fig. 9. Spring Set and Side Angle.

their sharpness and the angle at which they receive the strain of work; as also their retaining their keenness and set.

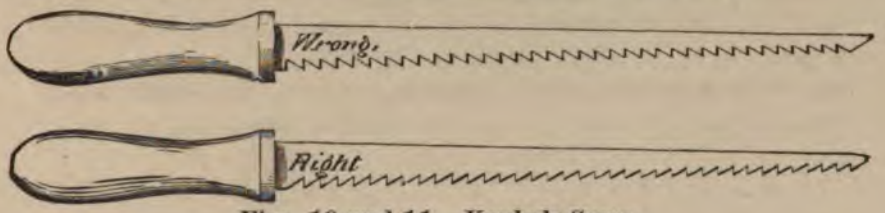
Fig. 9 represents the magnified teeth of a common hand saw with spring set.

The front edges have a bevel which throws the strain at right angles to the plane of that face (as shown by the arrows). The tendency is to throw the tooth in the *direction* of its set; and any one tooth having more spring set than the others will take undue work; will dull sooner and then spring *away* from its duty, lessening the set and causing friction and heating.

A tooth without fleam or side angle, Fig. 7, has no side strain, other than that due to the spring set. This fleam or cross angle decreases with the thickness of the blade; hence while not fit for heavy saws is proper for hand saws, which, also, have a slow duty. It is better

for soft woods, which are free from knots, than for hemlock or spruce, the hard knots of which would break fleamed teeth.

Referring to Fig. 6, tooth 1 would buckle and bend if given any spring set; 3, even if excessively long, would admit of ample.



Figs. 10 and 11. Keyhole Saws.

While the teeth remain sharp, spring set tends to increase; when dull, to decrease.

Even setting cannot be over-rated in importance. The tendency of set is to come back. Hence it is sometimes best to first *overset*, then

Fig. 12 and 13. Japanese Saws.

spring back. The setting should not be at a sharp angle but on a *curve*.

Even Swaging is as important as even spring set. A saw with the teeth spread the full width of the kerf will stand more feed than if

Fig. 14. Boynton's M Tooth.

each alternate tooth be bent for the set. Of the fifteen saws tested at the National Sawing Contest at Cincinnati, 1874, we believe that not one was "spring set."

The smaller the saw the greater the advantage of spread over spring set.

The operations of sharpening, setting, and swaging are described in detail in appendices to the present work.

Metals, bone, and hard fine-grained woods, require small teeth with

Fig. 15. Front Edge View, showing two Points of M Tooth dressed to cut in line on one side and two the other

little or no set; ice, and soft coarse-grained woods require them large, widely spaced, acute angled, and much set.

Wet wood is softer and more easily cut than dry, but requires a keener and coarser set saw, giving greater waste. *Gummy and resinous materials* and *ivory* require very keen teeth and slow speed, to avoid the

Fig. 16. Showing Space occupied by M Tooth.

dust being softened and made adhesive—which tendency is lessened by greasing the blade.

Table 1 shows the adaptability of various shapes and sizes of teeth to different work.

As regards the question of *pulling or pushing cut*, those of us who

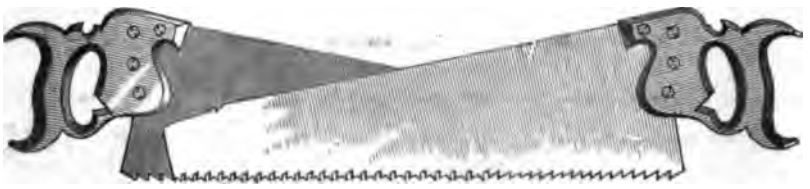


Fig. 17. Double Cutting Action of M Tooth Hand Saw.

have smiled—perhaps audibly—at the Japanese with their backward working saws, should bear one thing in mind before condemning *in toto* the pulling cut—that for keyhole or any other flexible-bladed saws, the backward or pulliug cut is the best; and our own usage with that exasperating implement the keyhole saw, is much more ludicrous and unphilosophical than the pulling out of the Niphonese.

Figs. 10 and 11* show the common or incorrect, and also the correct mode of placing the teeth of keyhole saws.

The Japanese saws are shown in Figs. 12 and 13.

The M tooth may be classed among those having no front rake; but ingeniously arranged so as to cut upon *both* strokes. Upon the same base as the ordinary V tooth are erected, in the same line, two teeth, or a double tooth; an M, in fact, with cutting edges fore and aft; its adjacent neighbor being alike M-shaped and sharpened on all edges, but generally both beveled and set oppositely. It may be said to do the

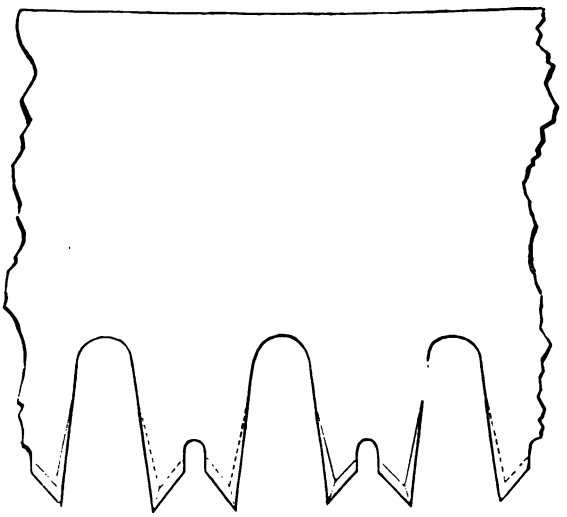


Fig. 18. "Lightning" Teeth.

same work, and have the same strength, as a tooth with no front rake; but in the same space arranges for a cut precisely as though the saw had been reversed. The M tooth is sometimes expressed as in Fig. 14. As the $\wedge$ angle in the ordinary M would be difficult to keep sharp, and ruinous to file-corners, it is now furnished by Boynton with a gullet, making it very economical of files and ensuring keen edges. The M teeth, which are veritable cutting edges, are edged on an oil-stone, after filing. A variation of the M tooth has its front edges raking backward, while it is still a double tooth; and we may style this the "W tooth."

* From *Polytechnic Review*.

One important feature in the construction of some hand rip saws and mill saws is that they have coarser teeth at the heel than at the point, so that fine teeth commence and coarse ones finish the cut. Fine teeth cut at the outset more smoothly than coarse ones, but as soon as they become clogged with sawdust they lose their efficiency to a great degree. As this partial clogging becomes more troublesome at the latter end of the stroke this "increment tooth" arrangement (similar in principle to the increment-toothed file so favorably known) brings the larger teeth into play just where they are needed, and while obviating the rank tearing of coarse teeth at the commencement of the cut, reduces the amount of splintering at the bottom of the kerf. This arrangement also makes the saw strongest at the heel and lightest at the point. See Fig. 19.

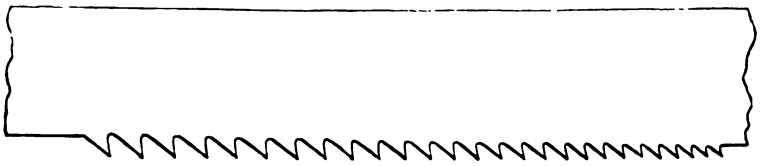


Fig. 19. Andrews' Increment Toothed Mill Saw.

The RECIPROCATING RECTILINEAR saw has many varieties. It may be

(1) strained in a frame or sash, and guided on both strokes, while cutting on one only;

(2) guided at both ends but not strained; pull cut;

(3) free at one end, with pull cut;

(4) free at one end, push cut;

(5) free at one end, cutting on both strokes;

(6) strained in a sash, guided on both strokes, and cutting on both;

(7) unguided at either end; handle at each end, and cutting on one stroke;

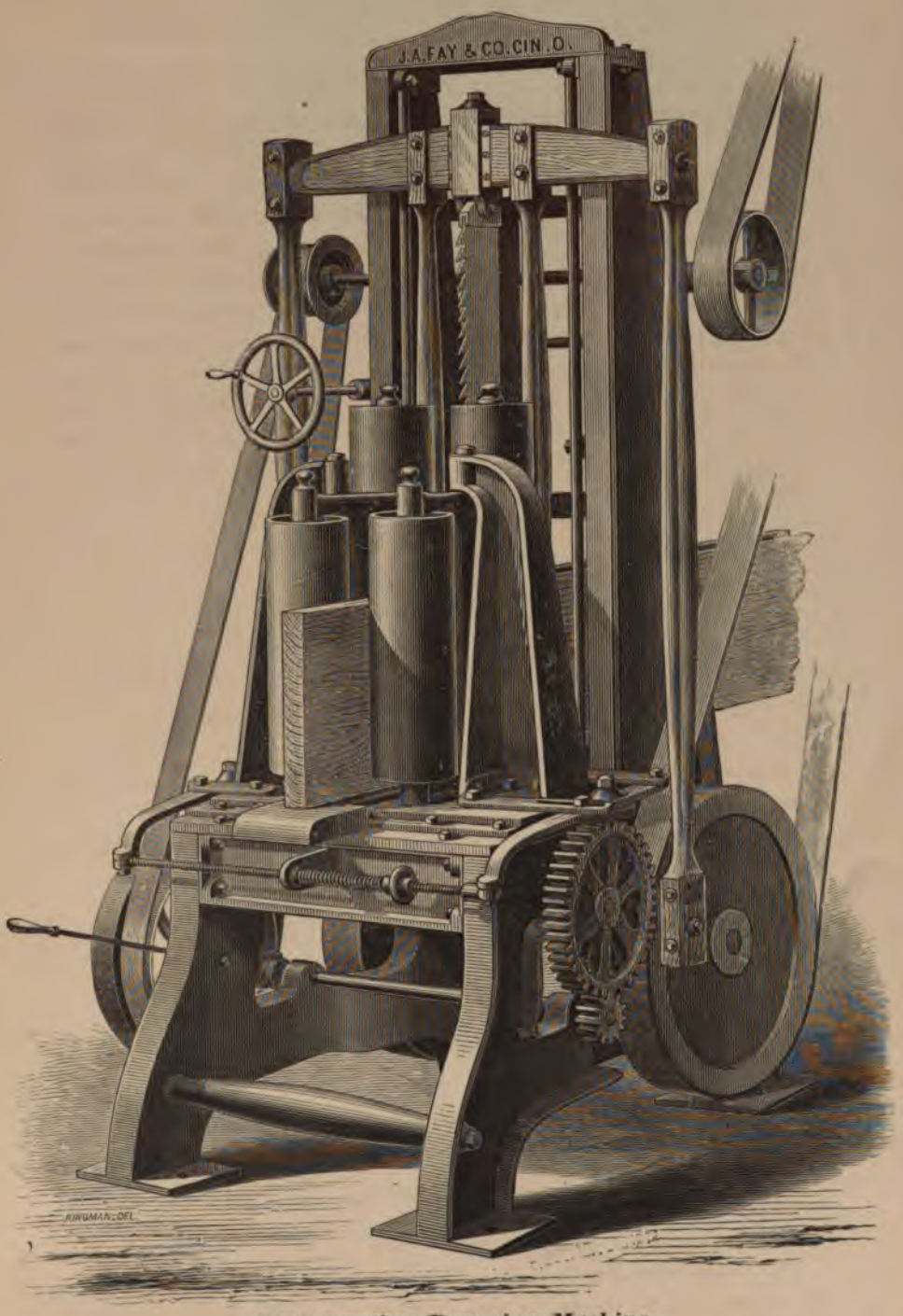
(8) unguided at either end; handle at each end, cutting on both strokes;

(9) strained by a weight at one end, cutting on one stroke;

(10) strained by a spring at one end;

(11) strained by a spring frame.

The *Single Sash Saw* is now out of date in this country; being rapidly superseded by the mulay and circular. A mulay with the same



Reciprocating Resawing Machine.

power applied will do nearly double the quantity of work, owing to its greater lightness and speed.

A single sash saw will make 150 to 200 strokes per minute and cut

Fig. 20. Mill-Saw Tooth.

about $\frac{3}{4}$ inch in hard and 1 inch in soft wood, at each stroke. It is generally 5 to 9 gauge.

Fig. 20 is a form of mill-saw tooth (Hoe & Co.)

But while the single sash saw cannot compete with the circular in speed of cut or quantity of lumber turned out, the *gang* sash, having several blades strained in one frame, has a greater *collective* speed and capacity; and in the form of the "deal-frame" used in England to resaw squared logs, is one of the most effective of all saws; making little kerf, having a high speed, and cutting many boards simultaneously; while gang-sawed lumber brings a higher price than that from circulars.

Fig. 21 shows one of the most improved American gang sash machines. The sash is 38 inches wide and contains 26 saws each 4½ feet long and 9 inches wide, No. 14 gauge; teeth 1¼ inches from point to point and the same depth, swaged to cut a kerf but $\frac{5}{32}$ inch wide. The "cant" is from 10 to 25 inches deep, the stroke 19 inches and the speed 225 revolutions (and consequently full cuts) per minute, at a feed varying from ⅜ to 1 inch each cut, according to the kind of timber. The machine is run by a double belt 20 inches wide over a driving pulley 4½ feet diameter, requiring an engine of 16 inches bore, 20 inches stroke, making 175 revolutions per minute at 60 lbs. pressure. The average capacity is 70 M feet of one inch lumber per day of ten hours —although it may be worked up to 90 M in the same time.

Fig. 22 shows a gang of Andrews increment toothed saws and the mode of hanging them so as to give proper "overhang."

The gang sash requires less labor to produce 1000 feet of lumber than the circular does. It works best in connection with a large circular which slabs the large logs into cants for it. The small logs had best be left to a small circular to saw into boards, scantling or other small timber. This gives the gang continuous work on timber worthy of it.

A gang making 240 strokes per minute will take about ¼ to ¾ inch feed per stroke in 12 inch cants, *i. e.* from 1 to 3 inches per second, according to the timber. The blades are, as a rule, made narrower at the ends than in the center. They are generally 8, 9 and 10 inches wide, from 10 to 16 gauge.

The thinnest saws possible with a fast gang are fifteen gauge.

The principal advantage of the gang is the extreme regularity in thickness of the boards it makes.

The Muley or Muley Saw (probably named from the German *Mühl-säge, mill-saw*) comes under the head of blades guided at both ends but unstrained. It has a pull cut and very rapid cutting speed, exceeding

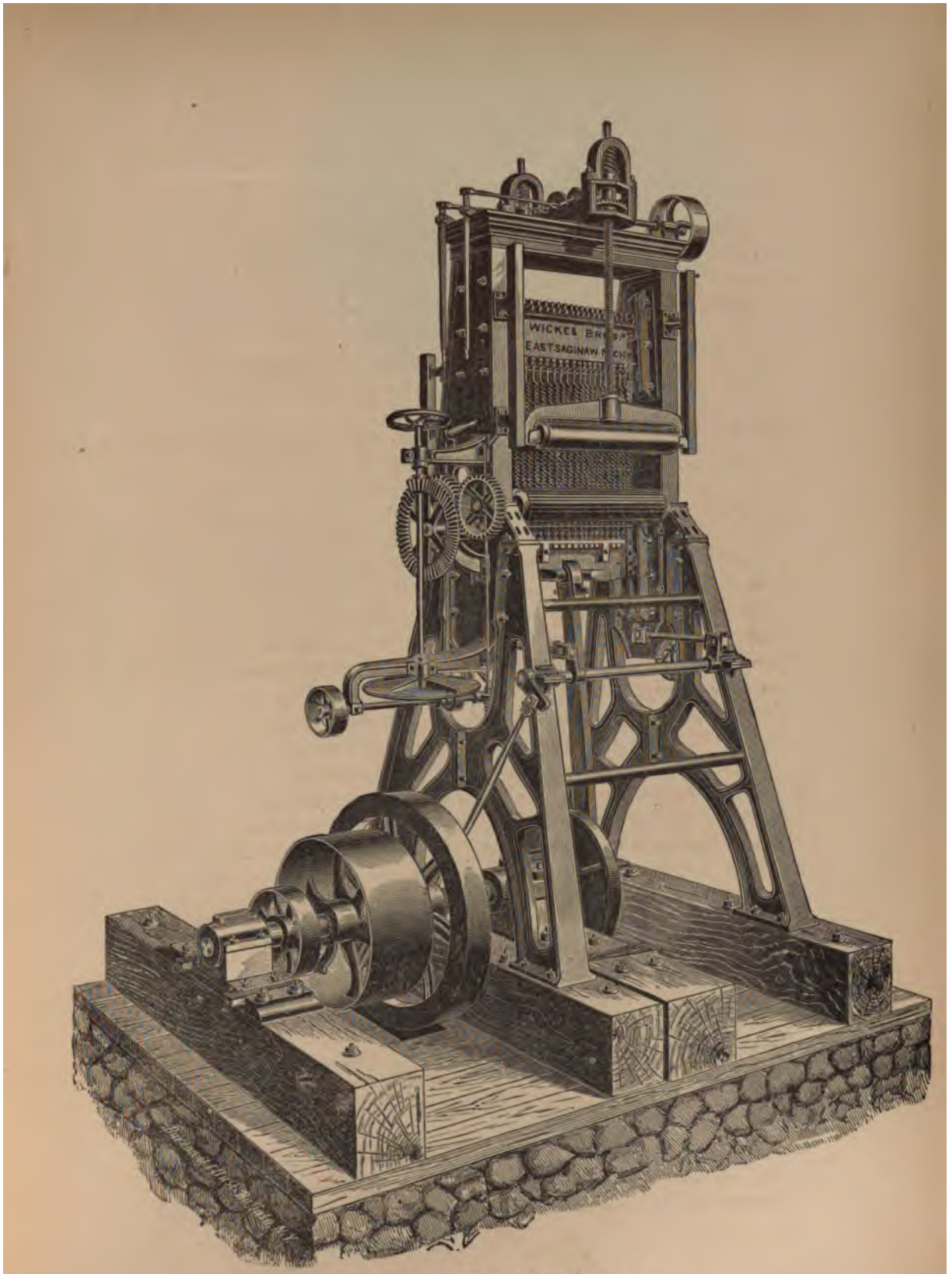
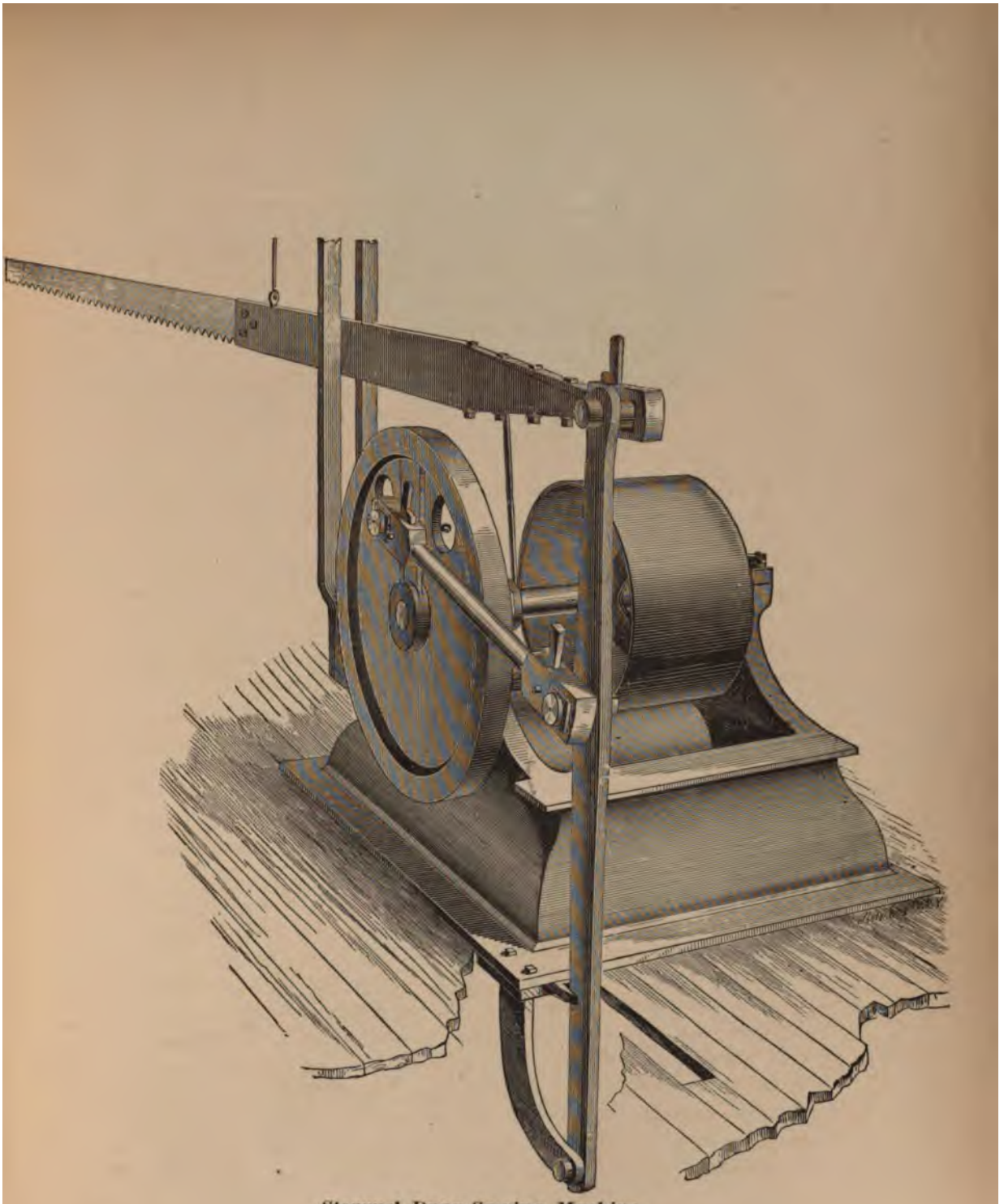


Fig. 21. Wickes' Gang Sash.



Stearns' Drag Sawing Machine.

in this respect the sash saw, which by reason of the inertia of the frame is more limited in speed. Its use is mainly in the Western States of America; and it is in its inception essentially bold and American. There being but little of the blade exposed unguided, its use at high speed is, however, quite safe. (See Addenda.)

The mulay saw for logs is generally 10 to 12 inches wide and $\frac{1}{4}$ inch thick, and making strokes of 20 to 24 inches at the rate of from 300 to 400 revolutions per minute, giving a cutting speed of about 600 feet per minute.

Mulay saws, when first introduced, were full $\frac{1}{4}$ inch thick. Now they are in use only $\frac{1}{8}$ inch thick—but generally are No. 7 gauge or $\frac{3}{16}$ inch thick.

The length of stroke for some log-cutting mulays 7 feet long is 28 inches; number of strokes 200 to 225 per minute.

The mulay jig (Fig. 23) is perhaps the best for soft wood.

A "smart mulay saw" making 350 to 400 strokes per minute will cut ordinarily $\frac{5}{8}$ inch hard and $\frac{3}{4}$ inch soft wood at each stroke.

Mulays are almost always the same width heel and point. A correspondent writes: "Some years ago, a party in Auburn, N. Y., took out a patent for a mulay mill that used a tapered saw wider at the top than it was at the bottom, but it was a failure."

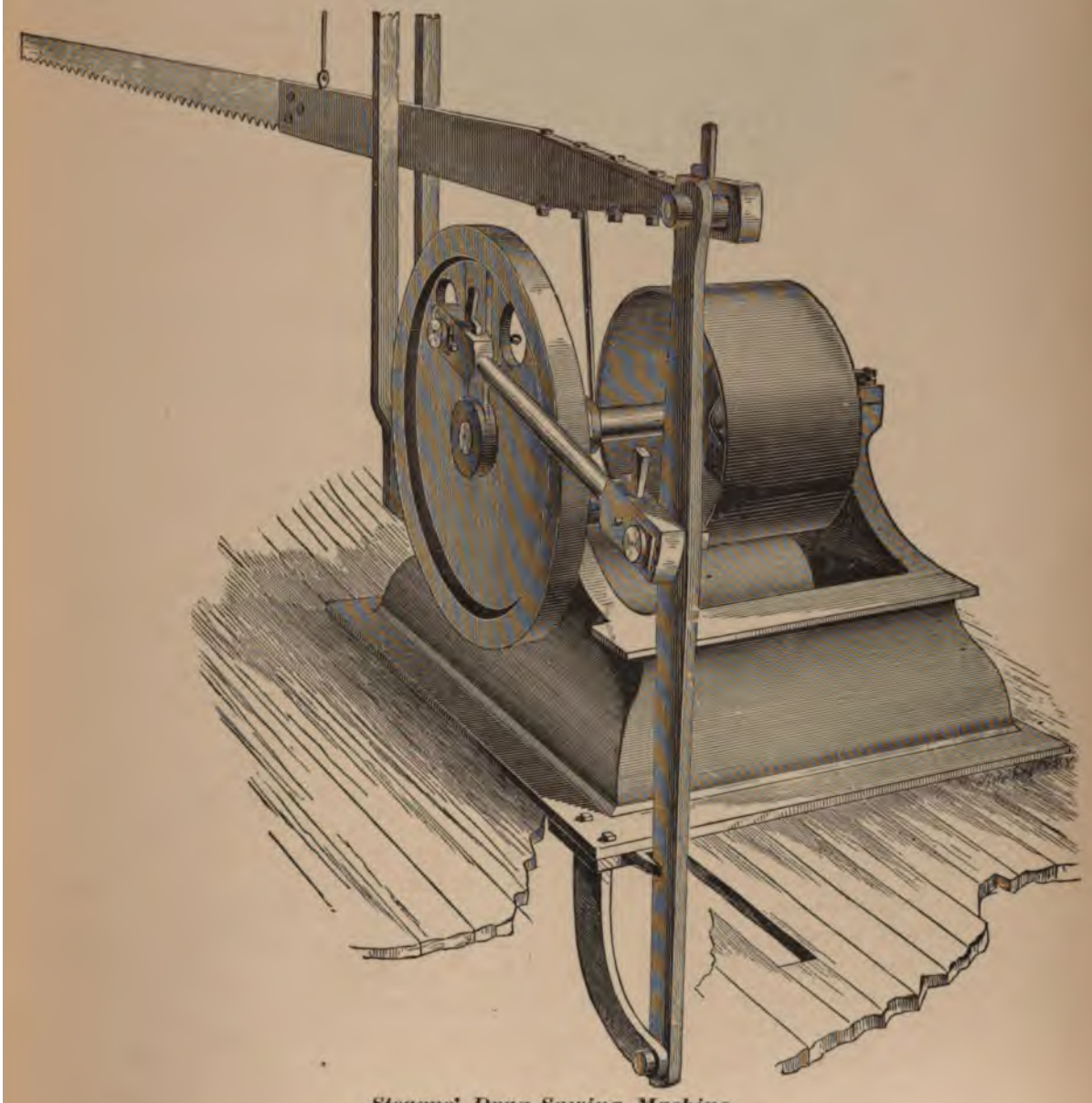
Mulay gang and mill saws were formerly made thicker on the front edge than on the back; but for some years past they have been given the same thickness on both edges.

The mulay *scroll* saw shown in Fig. 23 has a 3 inch stroke, and makes 1000 to 1500 revolutions per minute, receiving its power through a 3 inch belt on a pulley 6 inches diameter.

The Drag Saw, as its name implies, cuts on the pulling stroke. It is unstrained and unguided at the free end; and is, in fact, the Japanese hand saw, power driven and guided at the butt. Its stiffness is of course greater than that of a mulay of the same thickness; and it may be made thinner for the same duty. Its use is mostly limited to cross cutting felled logs and ship timbers; though more recently there has been brought out by A. Ransome & Co., London, England, an admirable horizontal adaptation of it to felling trees. (Figs. K and L.)

Fig. 24 shows the attachment of a large drag saw for butting.

The butting or drag saw is 7 to 8 inches wide at butt, 5 to 6 inches at point, and 10 gauge.



Stearns' Drag Sawing Machine.

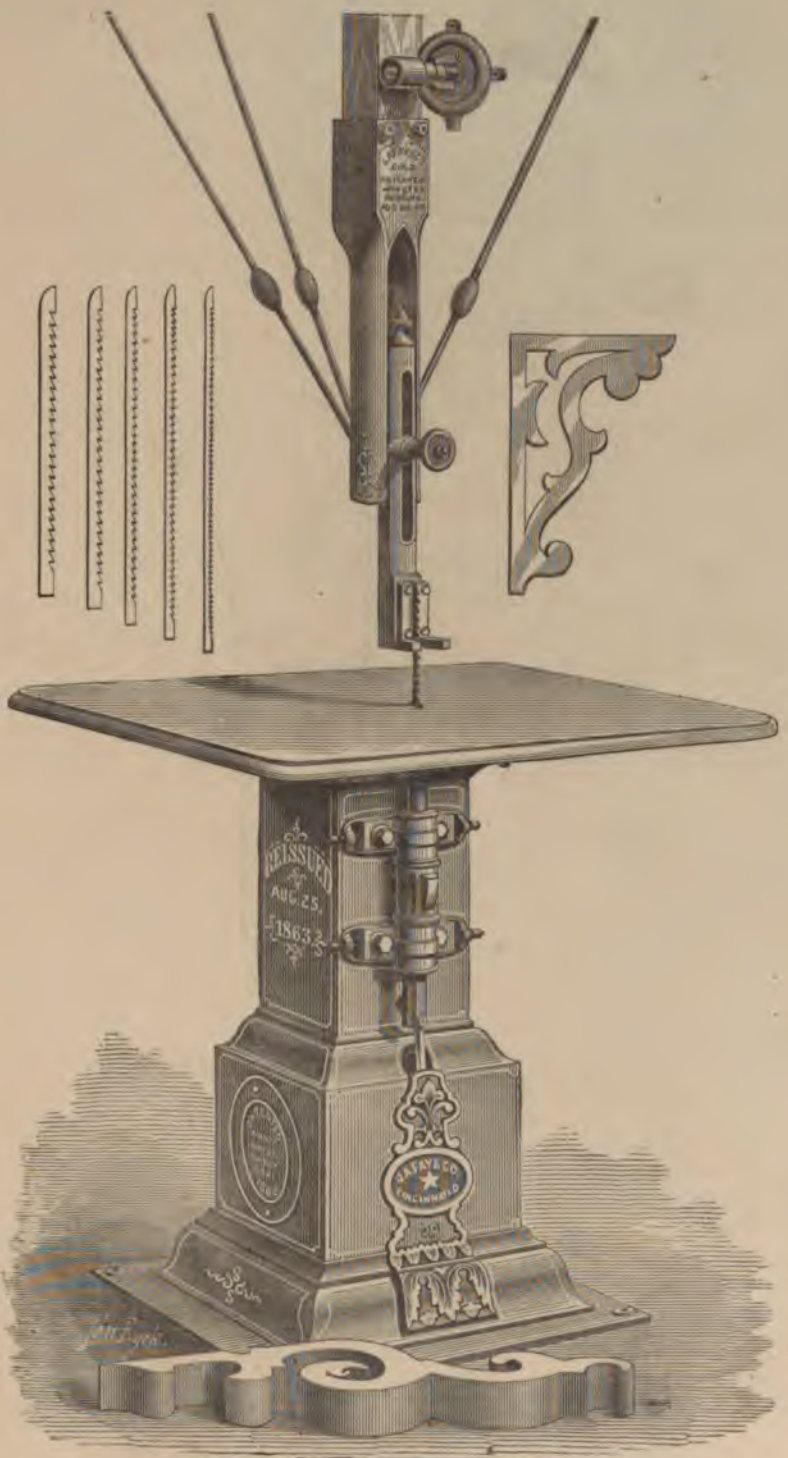


Fig. 23. Fay's Mulay Scroll Saw.

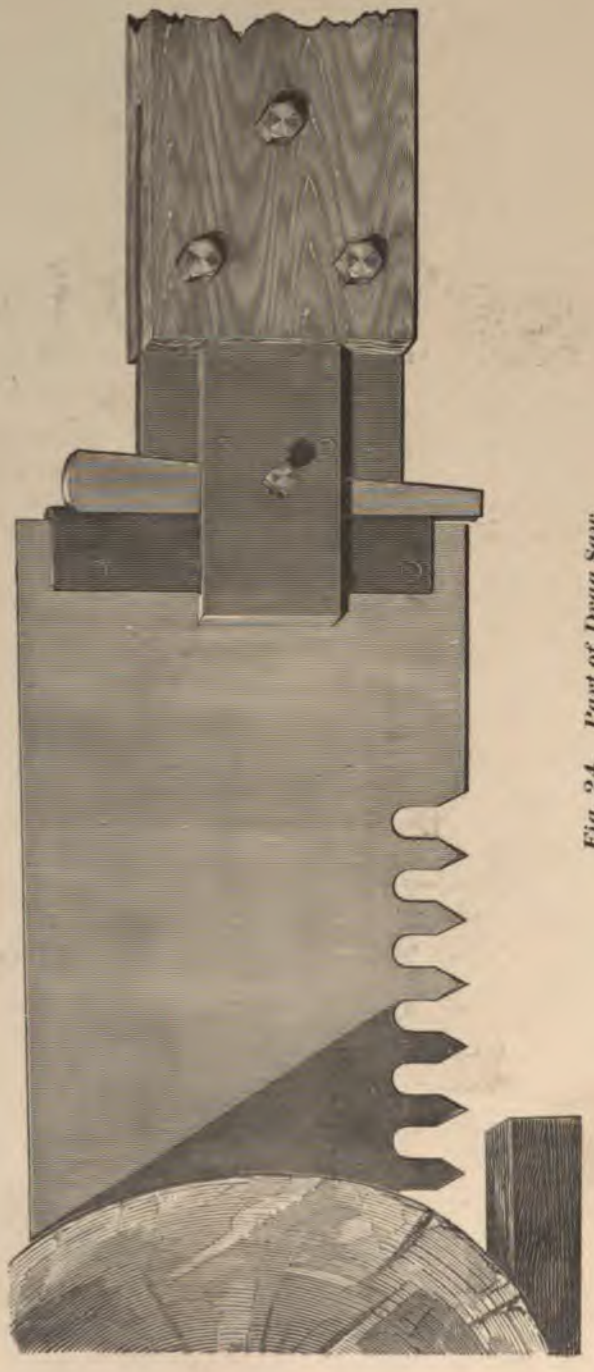


Fig. 24. Part of Drag Saw.

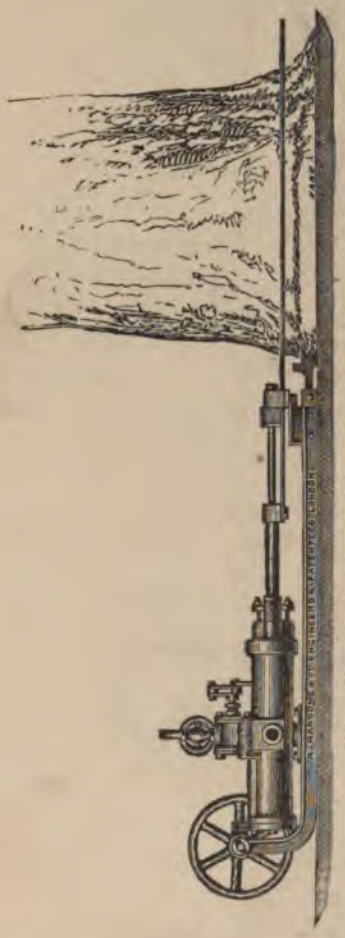


Fig. K. Ransome's Tree Feller in Operation.

Fig. L. Ransome's Tree Feller as a Cross-cut.

It is given mill teeth if intended to be used as a drag saw proper—that is, cutting on the pull stroke only; but if intended to cut on both strokes, it is given cross-cut teeth.

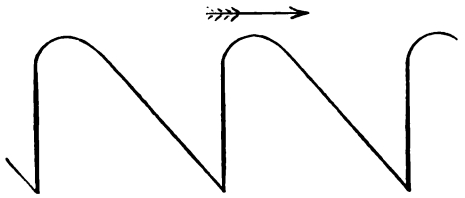


Fig. 25. Drag Saw Teeth for Firewood.

For farmers' use drag saws are 4½ to 6 feet long, and tapered from 7 to 5 inches; stroke 40 to 60 per minute. In shingle mills they are much heavier, and run 80 to 120 strokes per minute; are 5½ to 8 feet long; sometimes tapering from 10 to 6 inches and sometimes 10 to 12 inches wide throughout.

Drag saws for firewood are generally made with a tooth such as shown in Fig. 25. When the cutting is done on the pull stroke, thinner blades may be used than with double cutting saws; but the latter will saw smoother, and are used in drag sawing logs for shingle bolts, because it is desirable to make the edges of shingles as smooth as possible.

Fig. 26. Straight Taper.

Class 4, free at one end, and "push cut" is perhaps the most numerous of all—including principally all the varieties of carpenters' hand saws, of both parallel and taper blades, with and without backs.

In general, the teeth are of equal size throughout the length; but there is in some varieties—notably the hand-rip-saw—an increase in the size of the teeth from point to heel, referred to at the close of the remarks on saw teeth. But this increase is not always regular and graduated, but sometimes a sudden step.

Fig. 27. Gilles' Drag Sawing Machine.

This class may be subdivided into (*a*) taper saws, without frames, and (*b*) parallel saws, with backs. The following table gives lengths, sizes and spaces of teeth, etc.:

	Name.	Length.	Gauge.	Points to Inch.
Taper.	Hand,	26″	19	5 to 12
	Rip,	28″ to 30″	18	Heel, 3 to 5; Point, 6 to 8
	Panel,	14″ to 24″	22 to 20	8 to 12
	Compass,*	10″ to 20″	16	——
	Keyhole,*	7″ to 9″	21	——
Backed.	Tenon,	6″ to 18″	22 to 20	11 to 15
	Miter,	20″ to 30″	20 to 19	10 to 11

The *rip*, *half rip*, *hand*, *broken space*, *panel* and *fine panel* are alike in general appearance. *Chest* saws are merely diminutives thereof.

Figs. 28 and 29.

The blade is "taper" in order that it may be nearly equally stiff throughout; for ease in attachment of the handle, and to lighten it. This taper is either straight or curved (see Figs. 30 and 31).

The curved taper (Fig. 31) is claimed by the makers to somewhat lighten the saw, while lessening its liability to vibrate when drawn from a cut. The "increment" tooth of the rip saw is clearly shown in the figure.

The straight edge of Fig. 30 is graduated, as a rule; and the implement also has a level, scratch awl, etc.

Figs. 28 and 29 show a mode of strengthening the handle.

The *table* saw and the *compass*, or *lock* saws, differing only in size, and all used for curved line cutting, have narrow blades to permit their turning sharp corners.

* For curved sawing.

A convenient compass saw, made by McNiece, of Philadelphia, has the blade clamped in its slotted handle by means of a screw clamping ferule (see Fig. 32).

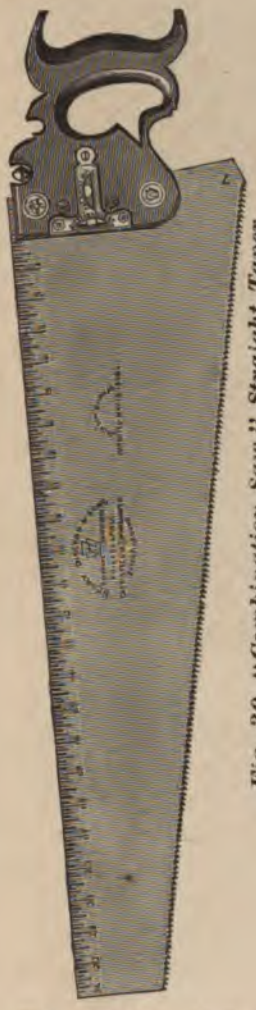


Fig. 30. "Combination Saw," Straight Taper.

Fig. 31. "Skew Back" or Curved Taper Rip Saw.

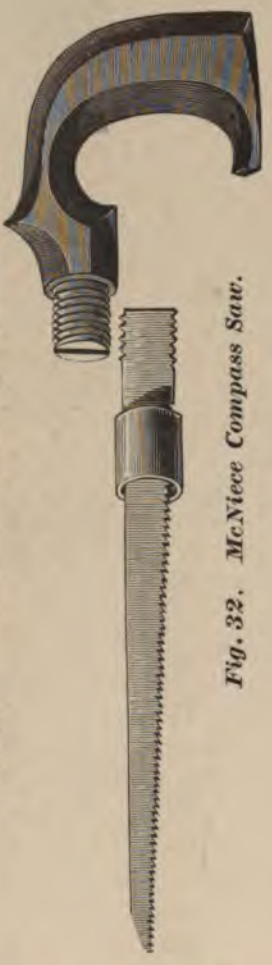
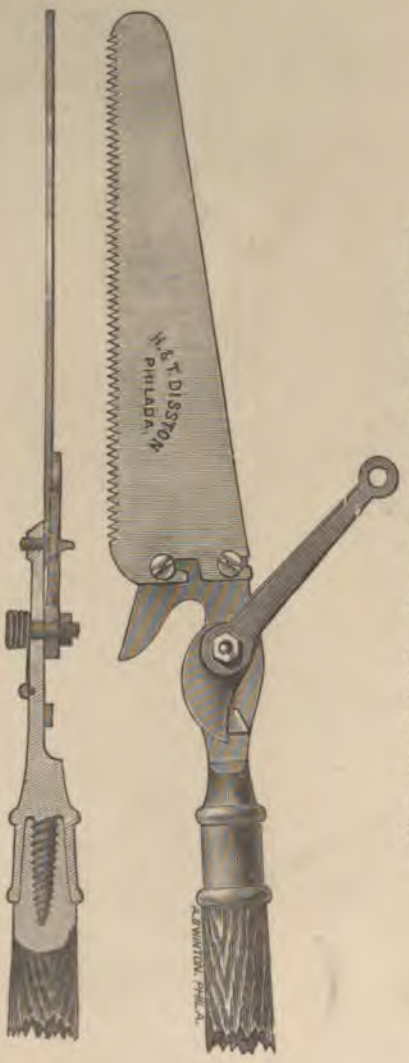


Fig. 32. McNiece Compass Saw.

The *keyhole* or *lock* saw is still narrower. It should be made with a pull cut for the reasons stated, page 17.

Pruning saws are coarser, thicker and keener saws than those for dry wood. They are sometimes made with half moon or briar teeth for rapid execution.

Figs. 33 and 34 show a pruning hook attachment to a pruning saw. The pond ice saw, generally supplied with a "tiller handle," is 7 to 8 inches wide at butt, 5 to 6 inches at point, and 9 to 10 gauge.



Figs. 33 and 34. Pruning Saw, Hook Attachment.

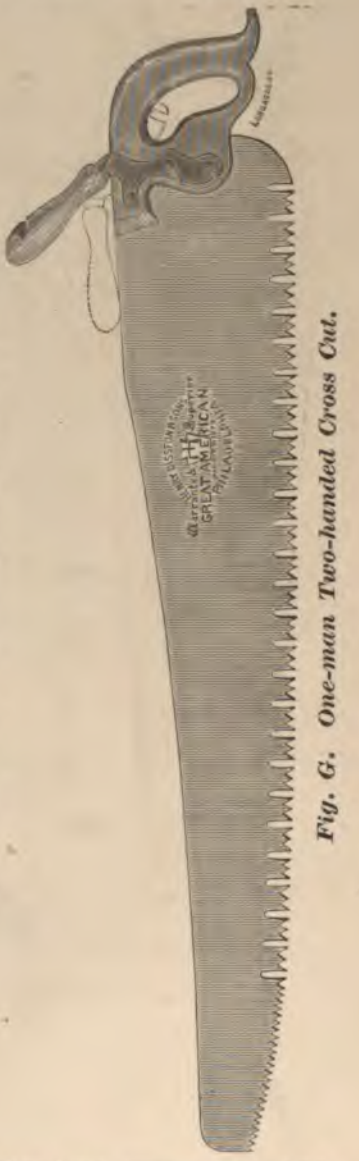


Fig. 6. One-man Two-handed Cross Cut.

Hand saws for ice are about 24 inches long, gauges 16 and 18; teeth regular cross-cut pattern, $\frac{1}{2}$ inch to 1 inch apart and deep, and with enormous set as this material clogs greatly.

The various *backed parallel bladed saws*, known as *tenon, sash, carcase* and *dovetail*, according to their uses, have thin and carefully hammered blades stiffened with a piece of metal sprung on. They are much employed for accurate work. Care should be taken not to spring the back by knocks.

Fig. 35.

Fig. 36. Miter-box Saw.

Fig. 38 shows a hand-saw with detachable back.

The Smith's screw head saw has a handle like a file and is used for cutting the slot in screw heads. It has a thick and hard blade.

The comb cutter's saw, sometimes called a "stadda," is double, the two blades being separated by packing, at any desired distance; one

edge being slightly in advance of the other so as to enter a new cut, which the other finishes. Thus spacing and depth are preserved equal. See Fig. 39. Similar saws, on a larger scale, have been used for cutting microscope and air pump racks.

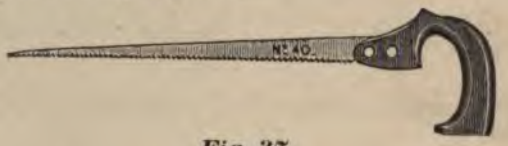


Fig. 37.

Fig. 42 shows an instrument designed to bare and roughen the edge of bone fragments without injuring the soft parts. The tube carries and partly exposes a stem, one side of which is a knife edge and the other a saw, and either of which can be worked at will.

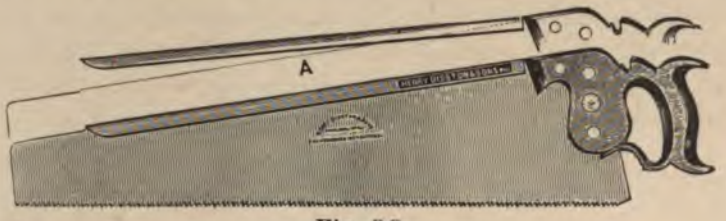


Fig. 38.

The increment tooth (see page 20) has these advantages for hand-saws: the fine teeth being used to start the cut and coarse ones to finish, a saw will work freely and easily. In hand-sawing the least

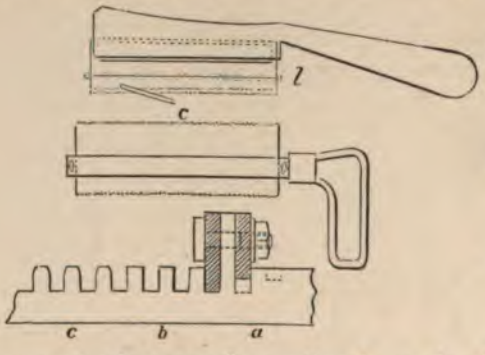


Fig. 39. Comb Cutting Saw.

Fig. 40. Adjustable-Backed Saw.

Fig. 41. Rack Cutting with Saws.

amount of power is employed at the beginning of the cut, but as the arm straightens at the elbow more force is used, and the coarser teeth allow it to be utilized because the space between the teeth

do not clog as readily as the fine teeth do, and the fine teeth do not catch at the beginning of a cut as do coarse teeth.

The teeth of a hand saw should be so truly filed that on holding it

Fig. 42. Protected Rasping Saw.

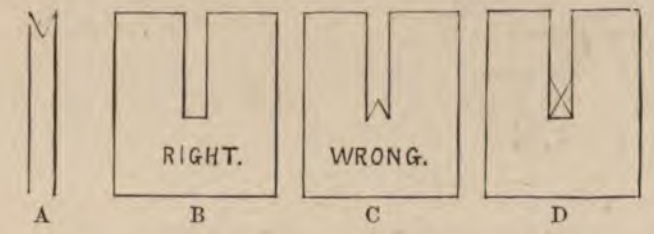
up to the eye and looking along its edge lengthwise it should show a central groove down which a needle should slide freely. See Fig. *A*.

The cutting action should be such that the bottom of the kerf should present the appearance of Fig. *B*, and not that shown in Fig. *C*.

Fig. 43.

Fig. *D* shows the proper cutting action of the teeth.

Saws free at one end and cutting on both strokes are comparatively rare. The M teeth hand saws and some butting saws mounted as



drags, are all that we call to mind. We give cuts of both herewith, Figs. 43 and 24.

Fig. 44 shows a larger saw of this type, to be used with two hands, and which may also be converted into a "two-man" saw.

Fig. *G*, page 32, shows a large two-handed cross cut for one man.

A double-edged "universal" hand saw (Fig. 45) has one side with M teeth for ripping and cross-cutting and fine V teeth on the other side, for mitering. This saw can be used where a wide blade cannot—and the handle is less liable to strain the operator's wrist than in the

Fig. 44.

case of a wide hand saw of the ordinary pattern having its handle at the upper corner of the blade.

The same double-edged saw, with sheath, has a pole attachable to its handle for use as a tree pruner; the lengths being 16, 18, and 20 inches. (See Fig. 46).

Class 6, strained in a sash, guided at both ends and cutting on both strokes, is a peculiar one. We call to mind but one representative—Robinson's horizontal veneer saw, shown at the Paris Exposition of

Fig. 45. "Universal" Saw.

1878. Very peculiar inclined guides give the blade what would correspond to overhang on each stroke, so as to give lead both ways.

Class 7 is the *pit saw*, practically the single sash, unguided and worked by hand. The blade is from 5 to 8 feet long.

Class 8 includes the "cross-cut"—frequently written "× cut." They vary largely in general appearance and in disposition, but have always for their object the severing each fibre in two places.

They are made double as wide in the centre as at the ends—to stiffen the blade and to allow for the greater amount of wear in the centre.

The "gains" or gullets in the centre are often made twice as deep as those at the ends, to save frequent "gumming."

In general there is one set of teeth termed "*scorers*," which sever the fibres at the sides, and others called "cleaners," which remove the central core or ridge, and plow out the dust made by the others. Cross cutting is like scoring a "gain" in a plank with the edges of a chisel, and then with the flat edge removing the severed portions.

Fig. 46.

"Cleaner teeth," "clearers," or "plows," are made slightly shorter than the cutters with which they alternate.

In the "Twin Clipper" (see cuts) there are two M's, or four teeth to a section; one M, or two teeth, set each way. The maker claims that where there are but two teeth (or one M) in a section, both teeth set the same way, their tendency is to draw towards the point and first take to the side of the kerf and draw or spring the section over until

it lets go when it reacts, cutting the sides of the kerf wavy, in this manner.

In this cross cut one pair of teeth is designed to counteract the

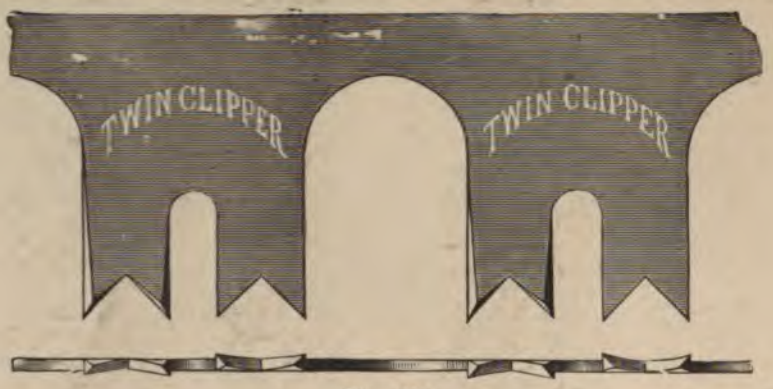


Fig. 49.

spring of the other, keeping the section straight and unsprung. It is also claimed that when a section has but two teeth it cannot be as stiff as with four.

The cleaner teeth of the "Twin Clipper" (see Fig. 50) are made by simply cutting out the inside section of two teeth, as shown by the dot-

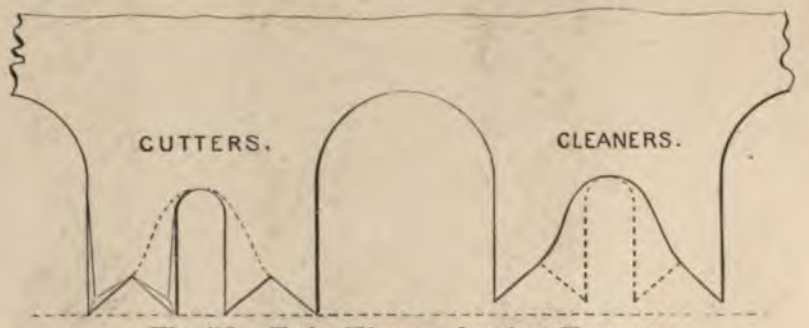
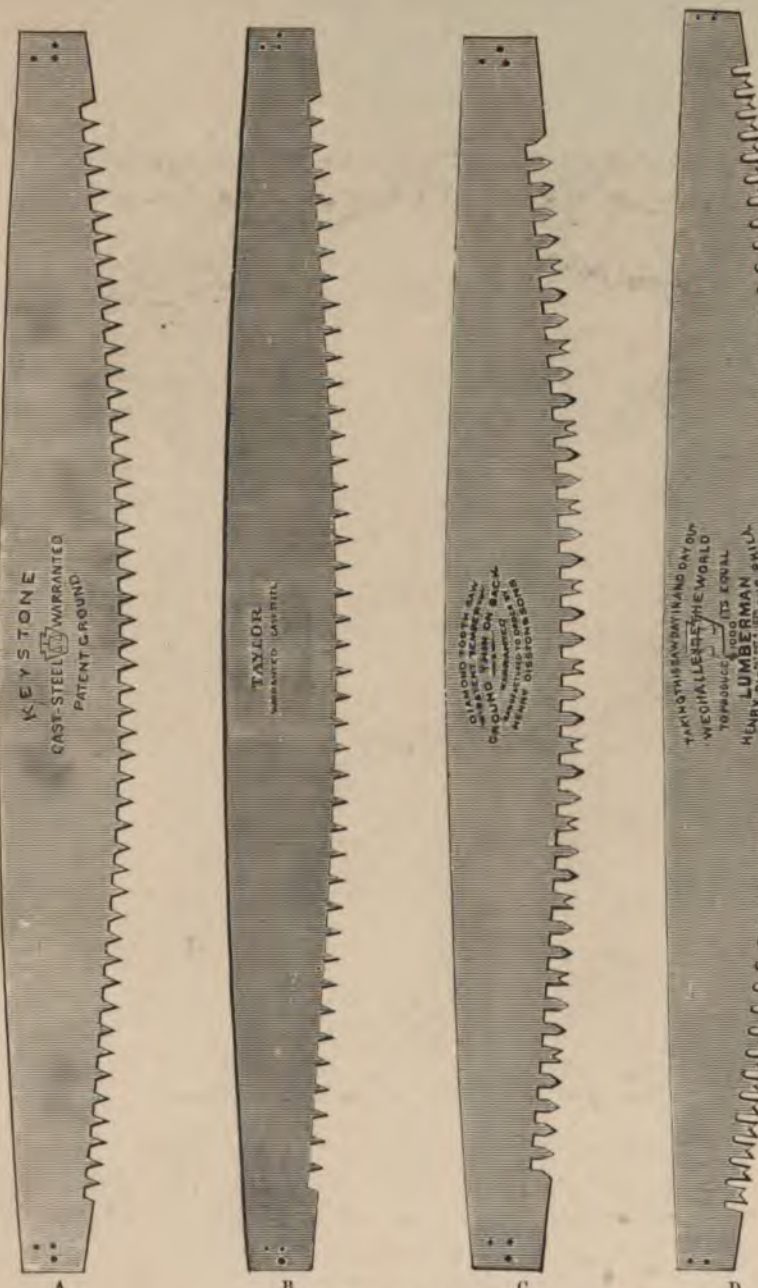


Fig. 50. Twin Clipper, showing Cleaners.

ted lines in the cut—leaving two sets of cutting teeth or scorers between each pair of clearers, which are about $\frac{1}{32}$ inch below these last.

The teeth of solid cross cuts are difficult to keep of proper length and shape. The saw requires frequent gumming, and in this process is frequently broken or sprung and kinked, and then, unless ham-


KEYSTONE
CASE-STEEL
WARRANTED
PATENT GROUND
TAYLOR
DIAMOND TOOTH SAW
GRADIENT TEMPERED
GROUND THIN ON BACK
HENRY DISSTON & SONS
LUMBERMAN
HENRY DISSTON & SONS PHILA.
A
B
C
D

Cross-Cuts.

mered and straightened by a skilled hand, will be sure to give trouble by running hard and sticking in the log. The perforated cross cut avoids gumming, and the teeth are easily kept just right.

Fig. 51 is Andrews' "Climax"; Fig. 52, Disston's "Great American." Fig. 53 is the well known "Tuttle" tooth. Fig. 54 shows a

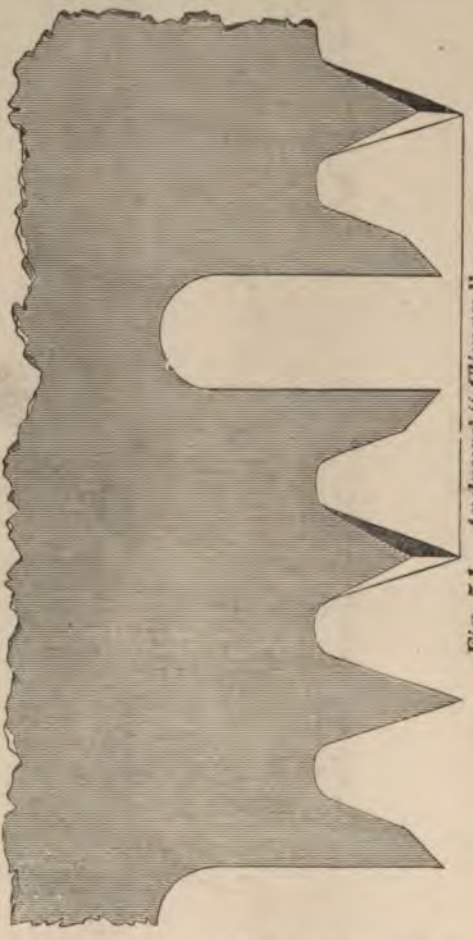


Fig. 51. Andrews' "Climax."

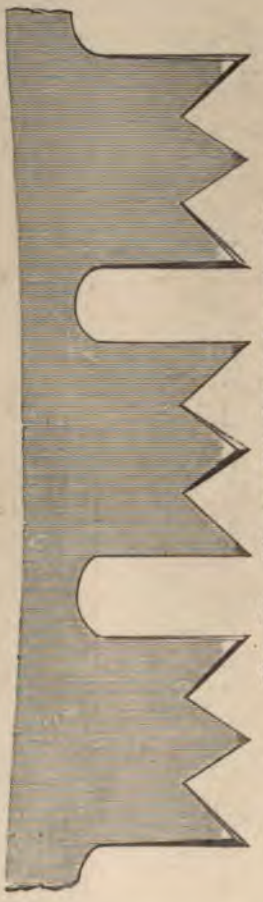
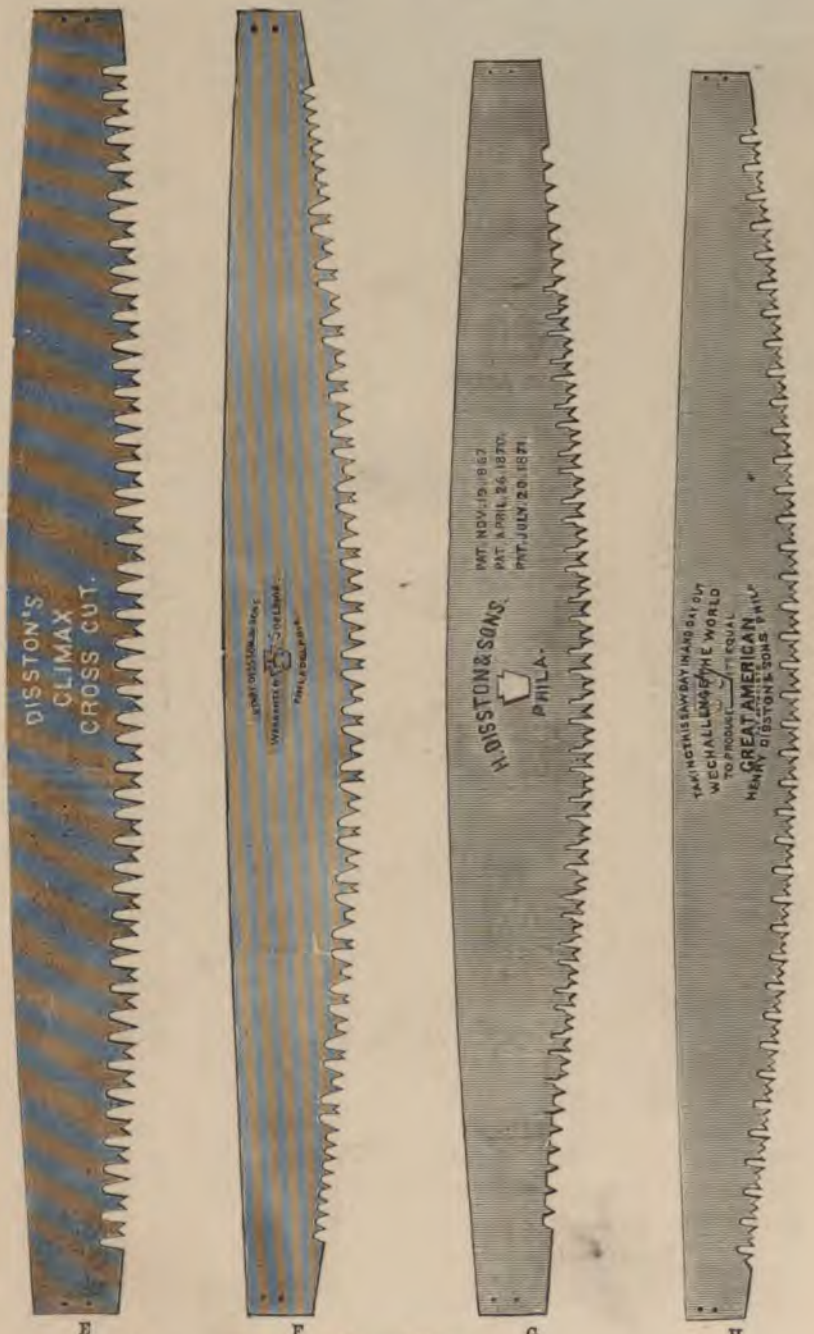


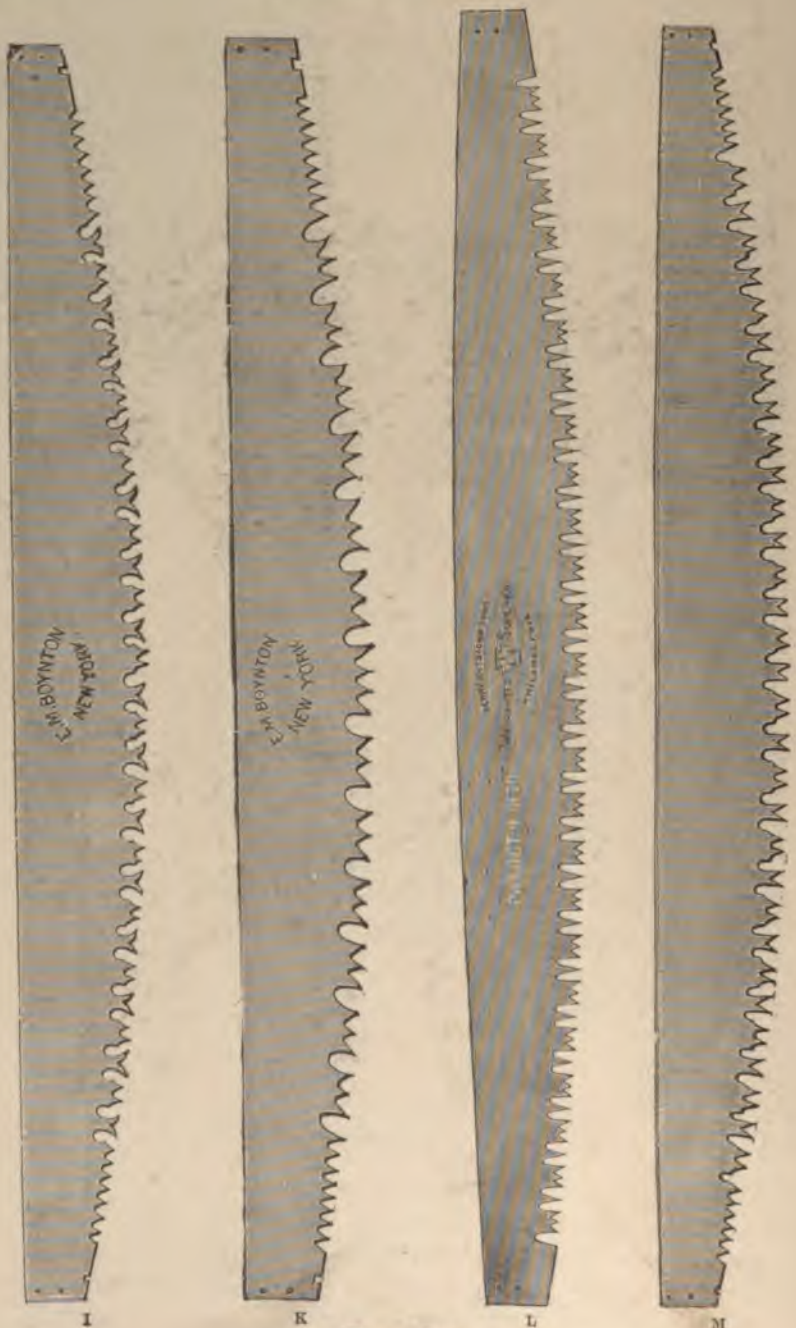
Fig. 52. Disstons' "Great American."

cross cut, in which the notch of each M is followed by perforations, as also are the larger gullets between the Ms and the Ws. Various styles of cross cuts are shown.



E F G H

4 *Cross-Cuts.*



I K L M

Cross-Cuts.

The Weight Strained Saw has only one application—to ice cutting. The blade is mounted vertically in a frame on a sled and is kept taut by a weight suspended in the water to the lower end. Arctic explorers use this saw for cutting their ships out of ice floes; and it has been used for heavy ice-cutting for commercial purposes.

Fig. 53. "Tuttle" Cross Cut.

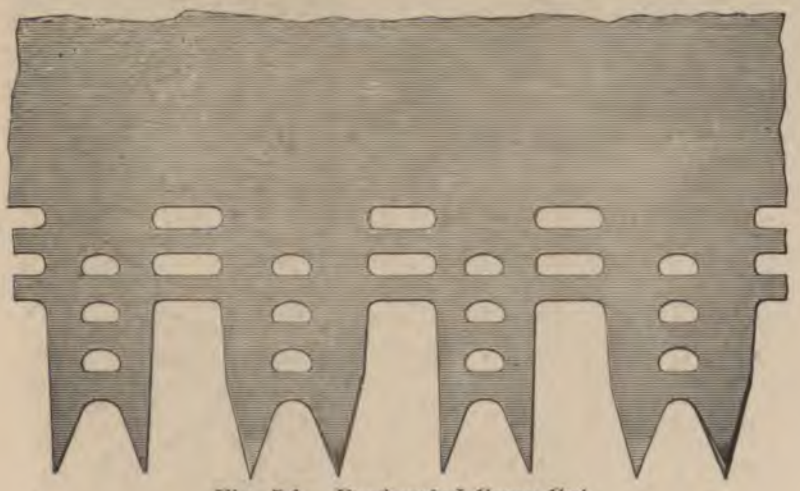
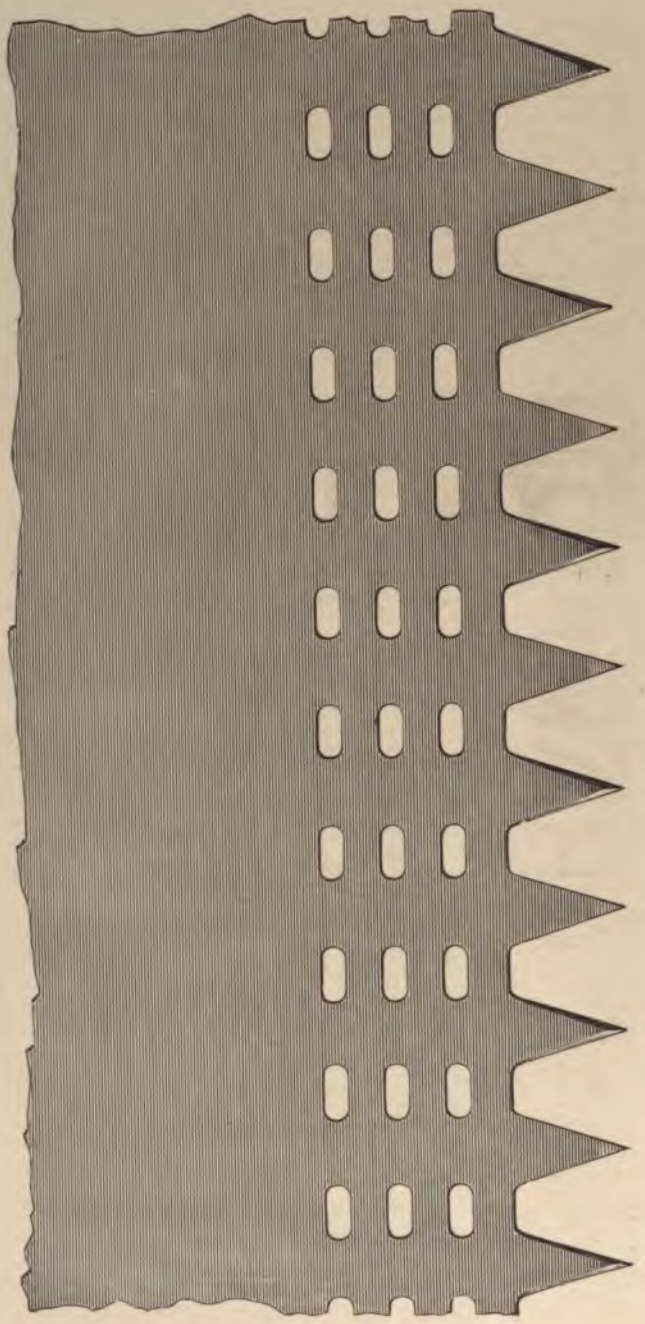


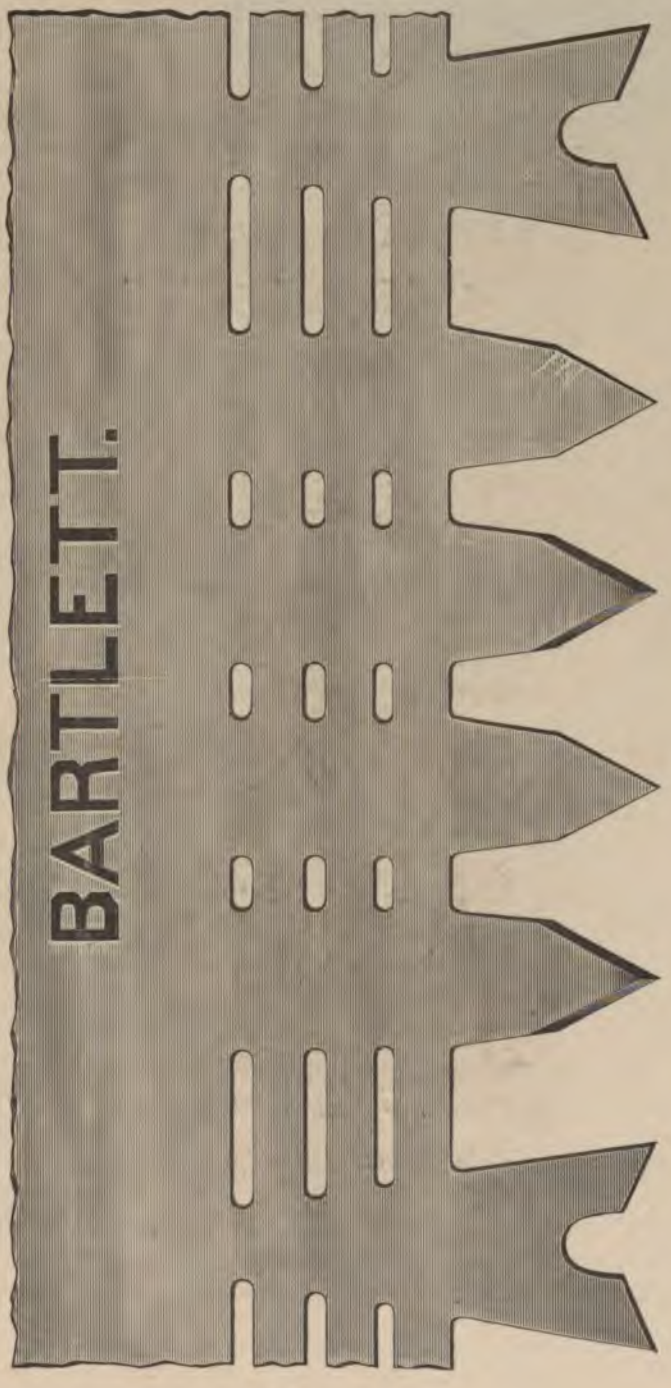
Fig. 54. Perforated Cross Cut.

The Spring Strained Saw, commonly known as the Gig, Jig, Fret or Scroll Saw, has a pull cut only; the return being effected by the same means that keeps it strained. It is light running and generally used for cutting out fine curved or scroll work; although of late years the band saw is superseding it for outside work.



CHAMPION

PREMIUM


BARTLETT.

Jig sawing really divides itself into two branches—sawing in irregular shapes on the outside of a piece of material, and the same process on the inside, known as fret-work.

The short and readily detachable blades of the strained jig saw can be so quickly withdrawn from one cut and inserted in another starling hole that the band saw has no chance to enter the field of fret work.

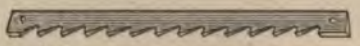


Fig. 66. Feather Edged Back.

It may be said to have influenced American architecture, which seems largely to have been arranged so as to give every opportunity possible, from crest and barge board to porch and railing, for the display of scroll sawing.

Fig. 67. "Fleetwood" Fret Saw.

Scroll-sawing blades are from 8 to 24 inches long and 13 to 16 gauge.

We may only notice that most makers grind their jig saw blades at the back, to avoid all error of setting, while Andrews grinds to a feather edge (Fig. 66).

The larger sizes necessitate a blower to keep the kerf free from dust and enable the workmen to see the lines of the pattern.

Fig. 67 and 68 show small fret saws of a familiar type.*

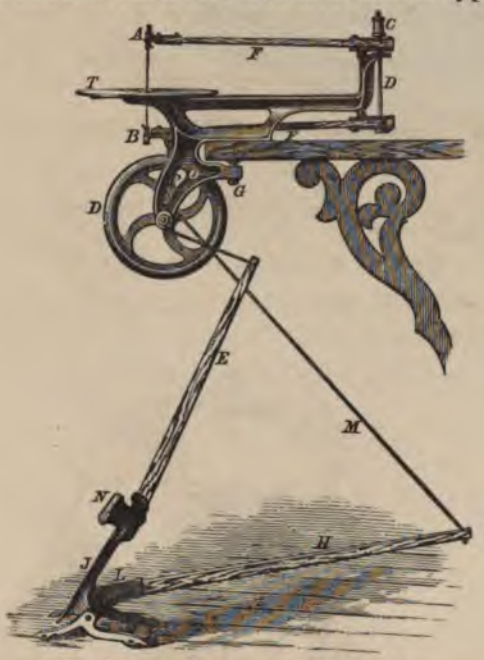
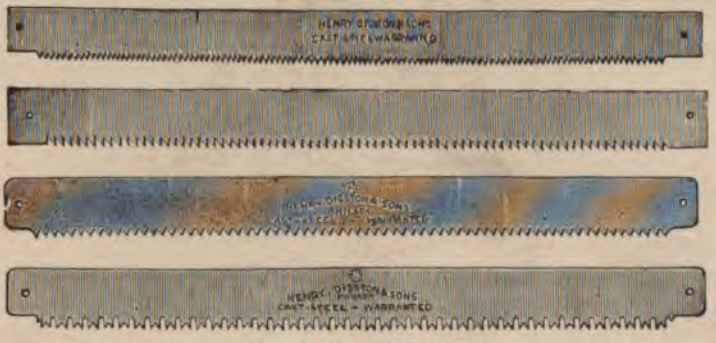


Fig. 68. "Victor" Fret Saw.



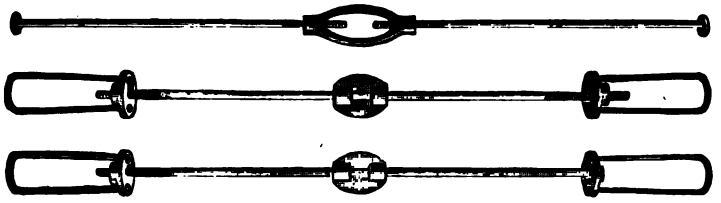
Buck Saw Blades.

The "Fleetwood No. 3" fret saw runs about 700 to 800 cutting strokes per minute. Faster speed is apt to heat the saw and burn the wood. Routers sometimes use a double-edged blade.

*Trump Bros., Wilmington, Del.

We hear of *round* saws for scroll work, but have not yet seen them.

The Buck Saw, or Wood Saw, is a familiar implement. It is made with the ordinary inclined *V* or hand saw tooth, and also with the double cutting M; the latter far superior.



Straining Rods for Buck Saw Frames.

Several American styles of the implement complete, of the blades and of the "straining rods." are shown herewith. American use has discarded the stick and twisted cord strainer.

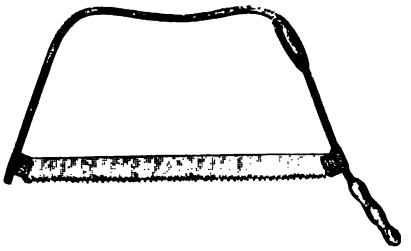


Fig. 69. Andrews' Steel Spring Bucksaw.

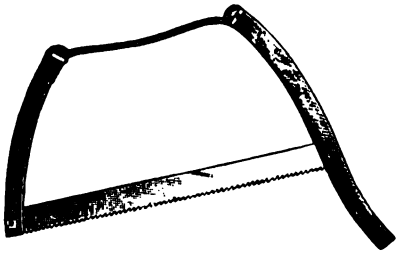
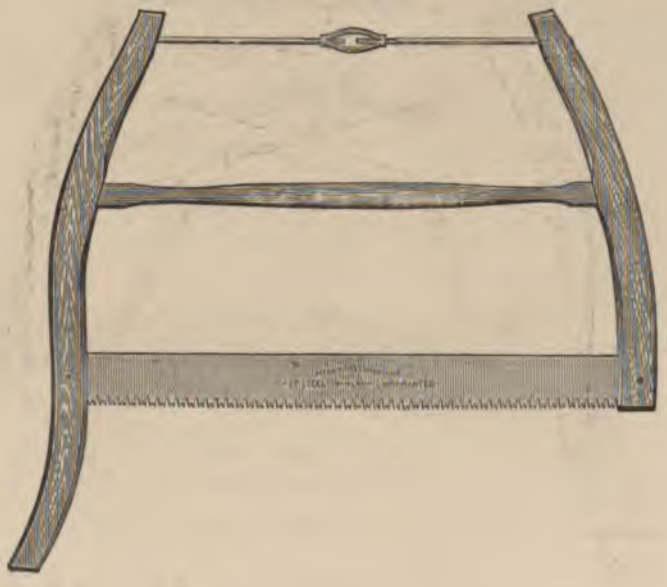


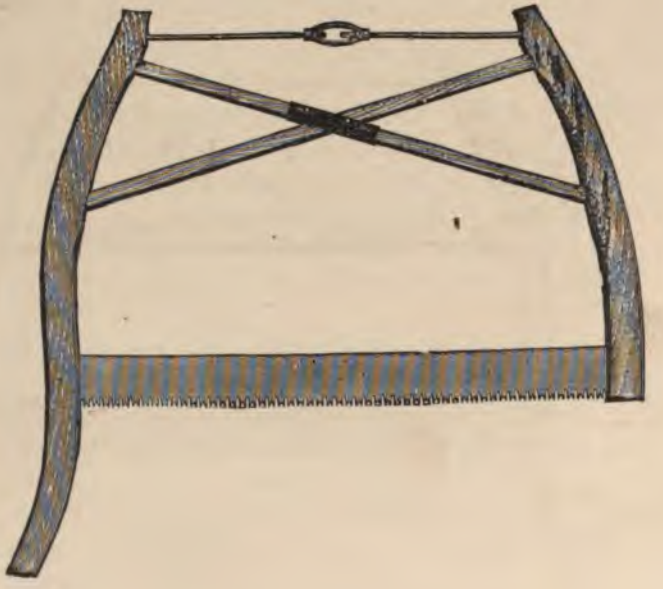
Fig. 70. Andrews' Bucksaw—Wood Frame, Steel Spring.

In frames, recent improvements enable a much larger log to be taken in. Figs. 69 and 70 show Andrews' frames, where the straining is accomplished by a steel spring comprising a part or the whole frame.

Web saws $\frac{1}{8}$ inch and narrower have wide ends, in order to give strength at the holes.

HENRY DISSTON & SONS
PHILADA





THE CIRCULAR SAW. During all the centuries which witnessed the birth and rise, the haughty supremacy and the fall of nations in successive turns, no important change was made for the better in the manufacture of saws, until, in 1790, a device was brought out by Brunel, by which cutting should be continuous. In other words, the application of the rotary principle to power-driven saws was given practically to the world.* While the circular saw was first practically used in Holland, its development is due to England and America—especially the latter.

The circular or "buzz" saw, not having inertia to overcome in revolving, has a higher cutting speed of teeth than the reciprocating, besides this advantage of continuous cutting.

It is made with solid and with removable teeth. We shall consider the solid-toothed variety first.

Fig. 75. Eight-toothed Weatherboard Saw.

(From Holzapffel, 1846.)

It consists, in its application to wood cutting, of a circular disk of steel, rolled to even gage, and then generally ground thinner either in the center or at the rim, after the teeth are cut.†

As a general thing, the teeth of circular saws are more distant, more inclined, and more set, than those of rectilinear. But their action may be referred to the tangent of the circle at each tooth, just as in straight saws to the line of the blade.

The teeth are more distant, because their great velocity makes their effect almost continuous. In one variety used for cutting feather-edged or weather boards and taking a very deep, wide cut, this is carried to an extreme—there being but eight sectional teeth (see Fig. 75). Fewness of teeth gives the necessary increased throat room for sawdust.

Their teeth are more inclined because they have additional power by reason of their great velocity, and hence can stand the extra front rake.

* The circular saw appears in a British patent of Miller, No. 1152 of 1771. The full text may be found in Richards' work on Wood Working Machines, page 6.

† See Appendix I for Manufacture of Circular Saws.

They are more set to make a wider kerf, required by reason of the waving and wabbling at high speeds of the disk, which cannot of course, even if perfectly homogeneous and true, and unaltered by heat, be kept as rigid as a strained straight blade.*

The circular saw is easily run, and at a high speed. But it requires continuous attendance, the work being so rapidly done as to be in the operator's hands nearly all the time.

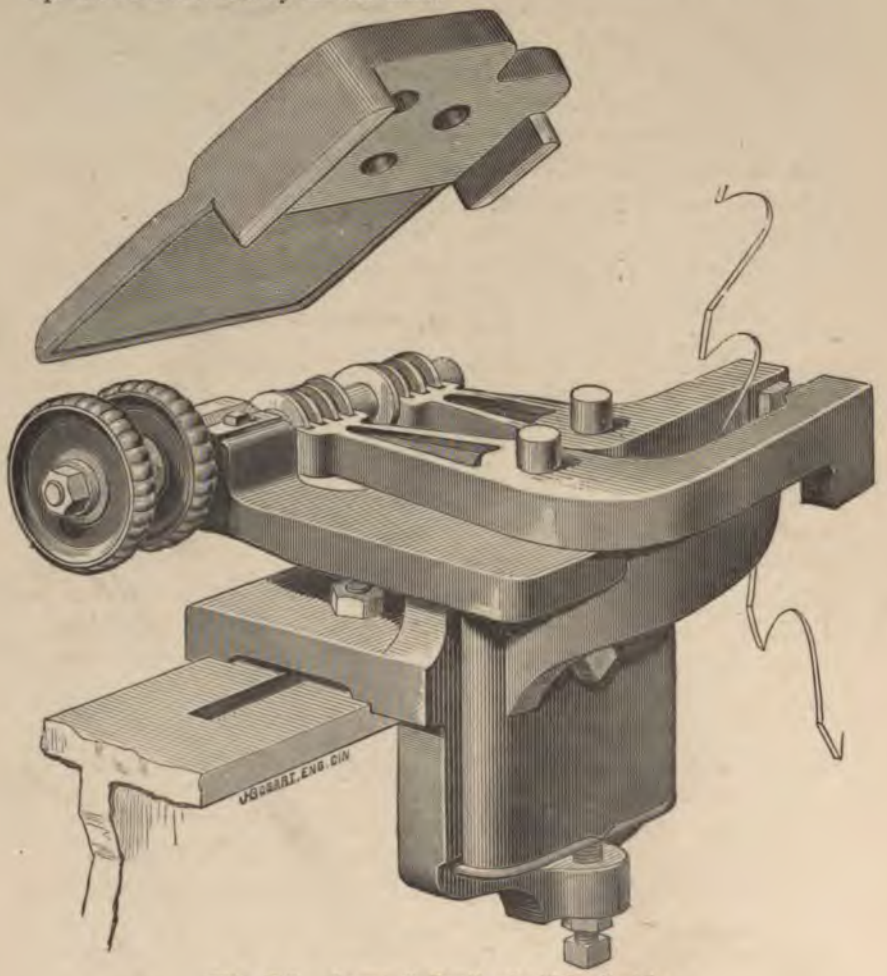


Fig. 76. Lane & Bodley's Side Guide.

* Something partly answering the purpose of straining is gained by the "side guides" of large circular saws. See Fig. 76.

Circular saws ordinarily run 9000 to 10,000 feet per minute, or 200 times as fast as a push cut hand saw, which makes about 100 feet per minute, cutting only half the time.

We may say for saws 12 inches diameter, 3000 revolutions per minute; 2 feet diameter, 1500 revolutions; 3 feet, 1000 revolutions; 4 feet, 750 revolutions; 5 feet, 600 revolutions.

Shingle and some other saws, either riveted to a cast iron collar or very thick at centre and thin at rim, may be run with safety at a greater speed. Shingle saws are tapered to 14 or 15 gauge, and run from 30 to 48 inches in diameter. We give herewith a

TABLE OF SPEED FOR CIRCULAR SAWS.

Size of Saw.	Rev. per Min.	Size. of Saw.	Rev. per Min.
8 in.	4500	42 in.	870
10 in.	3600	44 in.	840
12 in.	3000	46 in.	800
14 in.	2585	48 in.	750
16 in.	2222	50 in.	725
18 in.	2000	52 in.	700
20 in.	1800	54 in.	675
22 in.	1636	56 in.	650
24 in.	1500	58 in.	625
26 in.	1384	60 in.	600
28 in.	1285	62 in.	575
30 in.	1200	64 in.	550
32 in.	1125	66 in.	545
34 in.	1058	68 in.	529
36 in.	1000	70 in.	514
38 in.	950	72 in.	500
40 in.	900		

Richards, in his "Operator's Handbook," gives the following speeds for circulars:

Diam.	R. P. M.	Peripheral Velocity. Feet per min.
36 inches,	1500	14,100
30 "	1800	14,100
25 "	2100	13,700
20 "	2400	12,500
15 "	2700	10,600
10 "	3000	7,000

For shingle making the circular saw is sometimes run horizontally, as illustrated in Fig. 78, which shows the largest shingle machine in the world.

A shingle saw should be re-ground as soon as it wears down to 14 gauge, as the thinner the saw used the more profit. It does not pay to cut timber into sawdust instead of shingles.

Simonds 36-inch shingle saws (said to be not hammered) make from 1925 turns per minute, and 116 clips, to 2200 revolutions.

The circular saw should not be used on work thicker than one-third the saw diameter. A 20-inch square "cant" or log would necessitate a 60-inch circular saw, which may be $\frac{7}{32}$ inch thick and make a kerf of $\frac{9}{32}$ inch. But some economy of kerf and hence of time, power and material is gained by the "double circular" mill, having two smaller circulars rotating in the same direction, one cutting from the top, the other from the bottom of the log, in the same plane—one slightly in advance of the other (see Figs. 79 and 80).

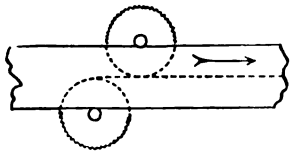


Fig. 79. "Double" Circular Saws.

Thus the 20-inch log cited above could be worked by two 30-inch circulars $\frac{9}{64}$ inch thick, and cutting only $\frac{13}{64}$ inch kerf. In general, the top saw is smaller than the bottom one, the lower one, after successive reductions of diameter by sharpening, being moved to the top mandrel.

In California, redwood logs ten feet in diameter are sawed with three 62″ vertical circulars, one above the other, in connection with a small horizontal circular which divides the board in the line of the arbor of the middle saw. The two lower ones cut 58 inches between them, and the upper one takes 29 inches.

In the choice of velocity and teeth of circular saws, there must be taken into consideration the hardness and grain of the material to be cut; its greater or less freedom from moisture, from gummy or resinous matters, and from spikes; also its size and the degree of smoothness required in the surfaces left. The harder the wood the smaller and more upright should be the teeth, and the less their velocity and the rate of sawing.

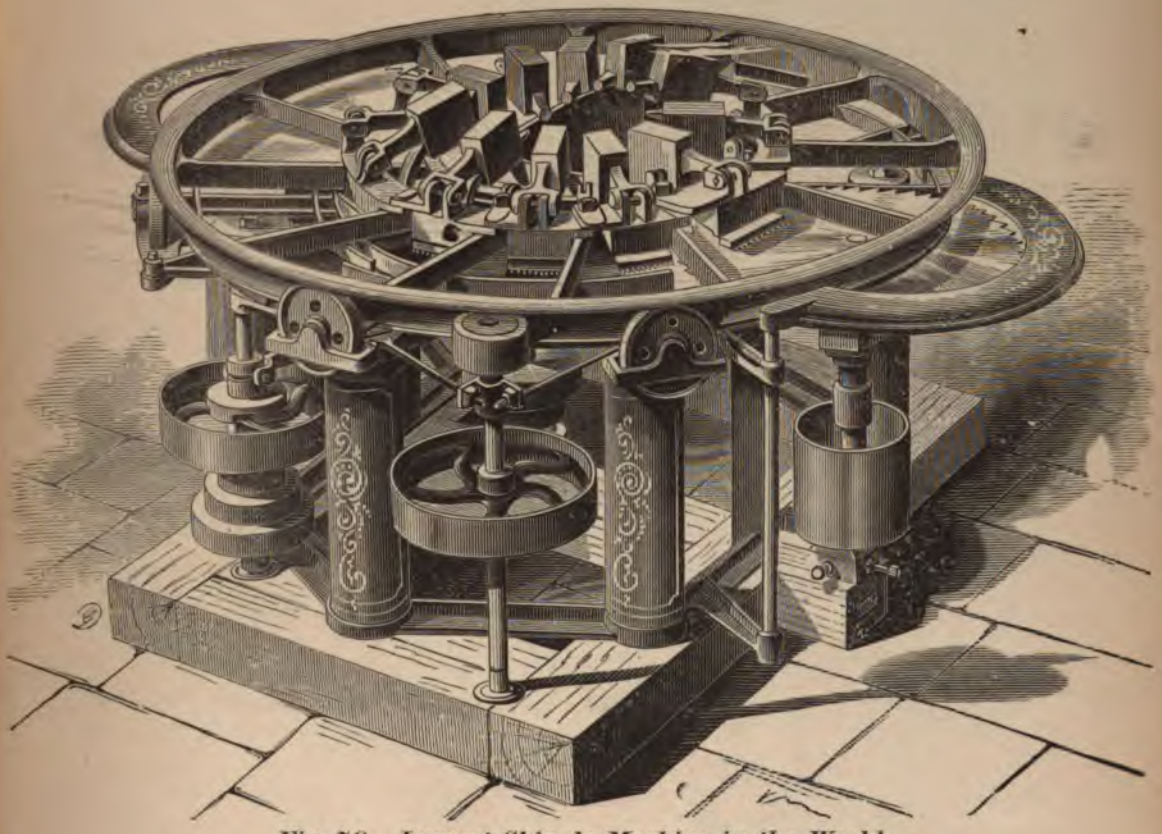
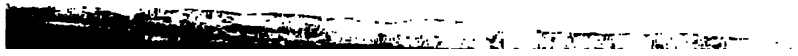
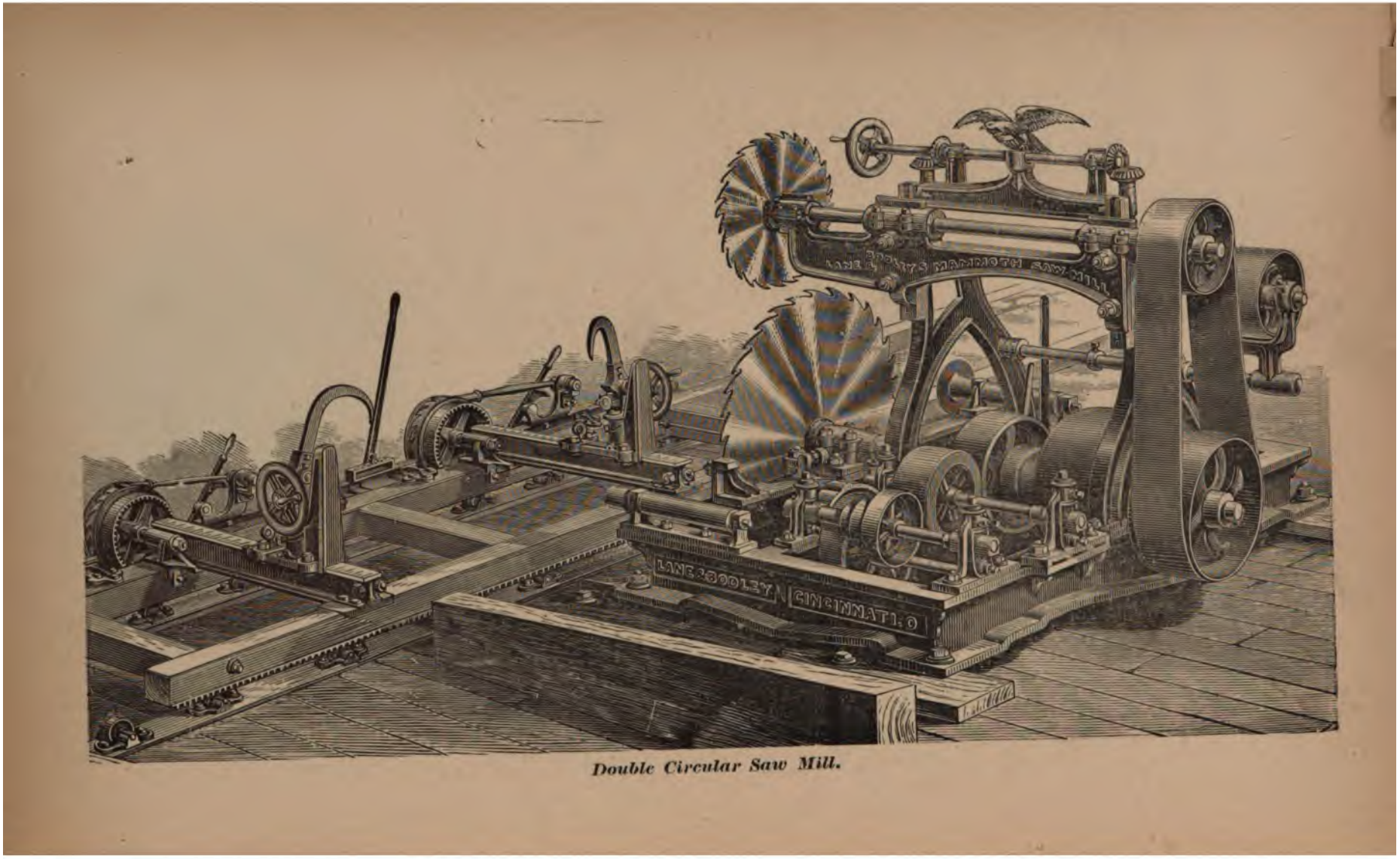


Fig. 78. Largest Shingle Machine in the World.





Double Circular Saw Mill.

Double Circular Saw Mill.

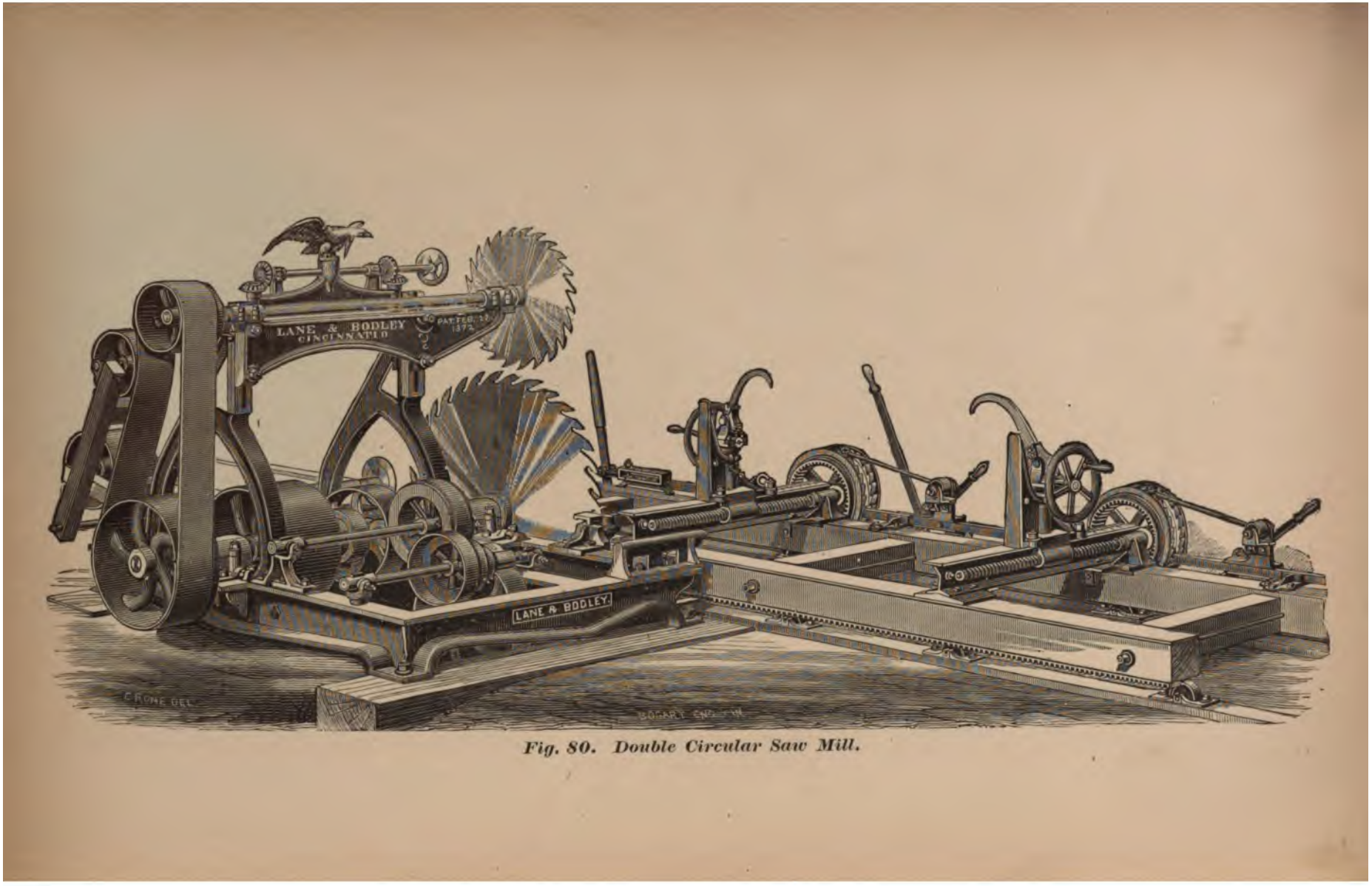


Fig. 80. Double Circular Saw Mill.

Fig. 81 shows the circular saw solid tooth for soft wood; Fig. 82 for hard wood..

In cutting lengthwise with the fibres (slitting, ripping), the teeth should be coarse and inclined, and the speed moderate, so as to cut rather than abrade; as fine sawdust takes more power to make it than coarse.

Cutting across grain (cross-cutting, crossing) requires finer and more upright teeth and greater velocity than in the last case, so that each fibre may be rather *cut* by successive teeth than *torn* by only one.

They should be as hooking as they will bear, except for lath saws, where the stuff is fed by the saw under the arbor, and for side cutting shingle saws, where this would cause too fast speed.

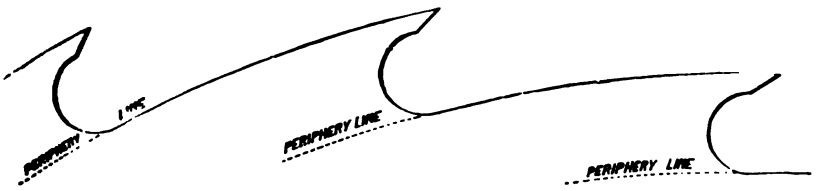
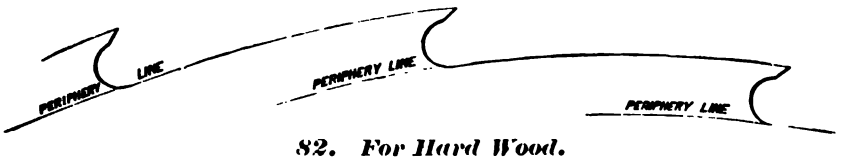


Fig. 81. For Soft Wood.



82. For Hard Wood.

The more inclined a circular-saw tooth is the easier it cuts. With less rake, however, the cut is smoother.

The teeth of the "circular" meet the fibres at varying angles. The fibres at the top of the "cant" are met at a very acute angle; those at the bottom at almost a right angle. (Fig. K.) It follows that the first are cut to the best advantage, and that narrow cuts—that is, those of medium height of cut—are sawed less economically than thick ones, the position of the table being the same.

Theoretically speaking, to effect the greatest economy in cutting, the table or carriage should be kept high up, so that the cant should be as nearly as possible tangential to the disk.

Figs. N, O, P show teeth made to various tangents.

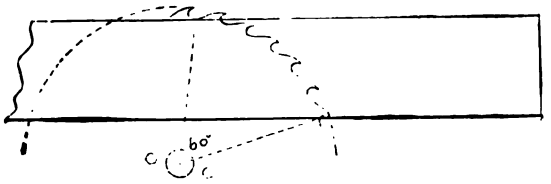


Fig. K. Action of Top and Bottom Teeth of Circular Saws Compared.

For pine, spruce and hemlock the teeth should be cut to a tangent to a circle half the saw diameter.

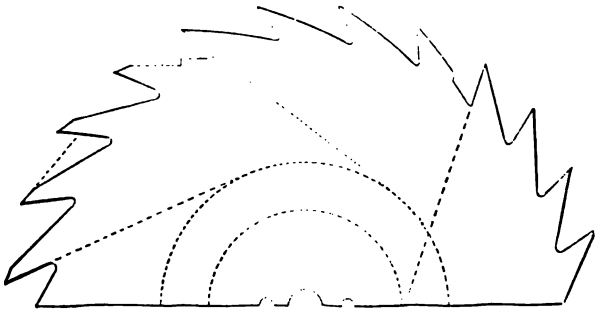


Fig. N.

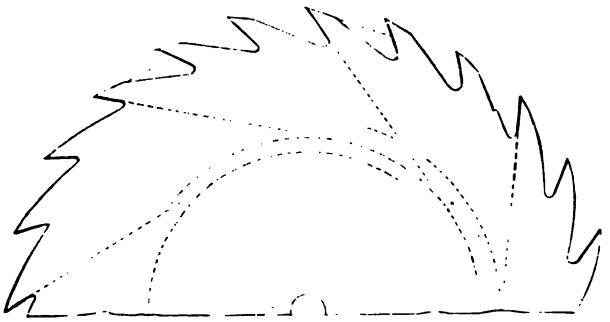


Fig. O.

The old "Barber" patent tooth had the under side concaved out, and cut very sweetly. The Emerson inserted tooth of the present day has this same feature.

The Knowles tooth for circulars (Fig. 86) had its back slightly relieved—which really amounted to having the point slightly upturned.

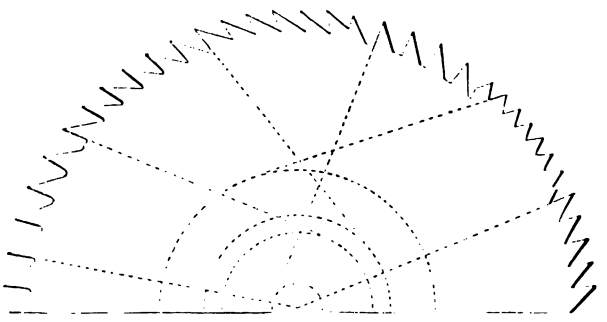


Fig. P.

The Gridley tooth for circular saws, shown in Fig. 83, as in order for work, has both spring and spread set. By use it becomes worn and rounded, as in Fig. 84. For light power and tough sawing it is said to do well. Its cutting point must be kept up square and full, as when rounded and dull (Fig. 84) it takes more power and turns out poorer lumber. It should be filed almost exclusively on the under side (as should any other tooth.)

An arrangement of circular saw teeth, which is a development of the increment tooth referred to under the head of teeth, has sections of the periphery arranged with increasing spaced teeth—the inventor claiming smoother cutting with less consumption of power. He states that at Cincinnati a 7 gauge, 56 inch, variable spaced circular used from 7 to 20 HP less than any other of the same thickness. (See Fig. 85.)

The points *only* of circular saw teeth should touch the lumber. They should be *kept* sharp by constant filing, and set by springing and swaging, so as to clear the blades.

The American tendency is towards extra thin saws, as lumber becomes more and more valuable. They are now made to 54 inches diameter, as thin as No. 12 gauge at rim and 11 at centre; 66 to 72 inches diameter, No. 10 at rim and 9 at centre. In extra thin saws it is necessary to use a larger number of teeth than in thicker ones. Every $\frac{1}{16}$ inch saved in the width of saw kerf saves 1000 feet of lumber in every 16 M sawed.

A circular saw has a great amount of difficult work to do, rapidly. It is something more than a hard steel disk. It must keep its position and work well when in rapid rotation and doing hard duty.

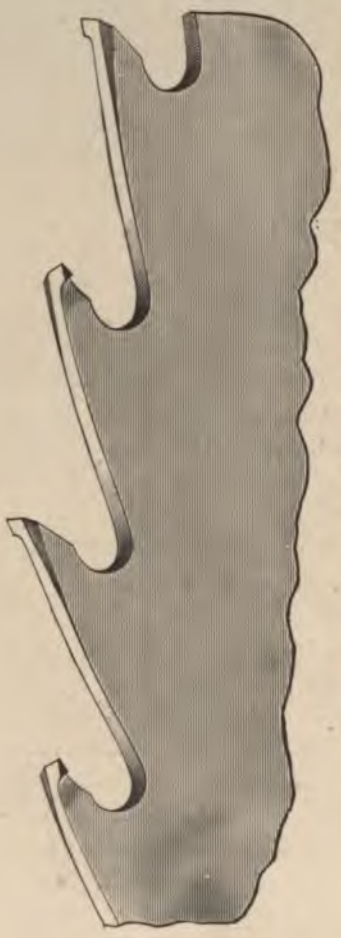


Fig. 83. Gridley Tooth, in good order.

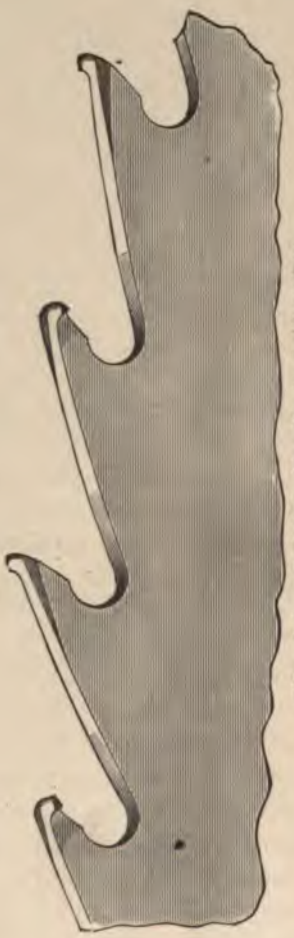


Fig. 84. Gridley Tooth, in bad order.

There is little real difficulty in making a "circular" with almost any kind of tooth, that will run well when new; but the steady use and constant changing of the teeth for months are sure to point out all their defects.

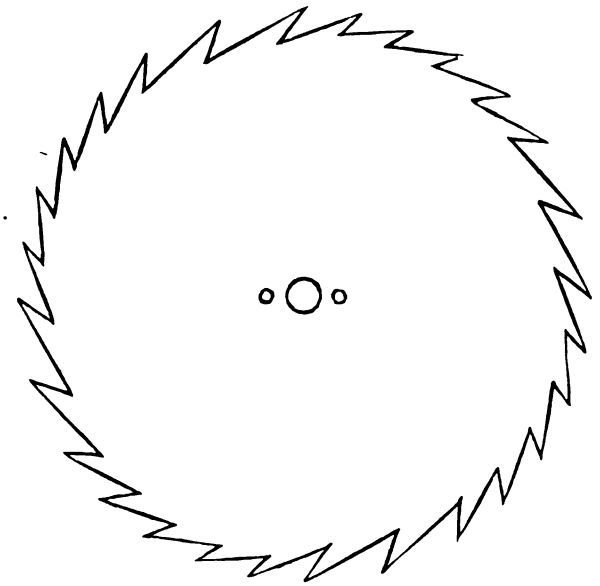


Fig. 85. Andrews' Increment Toothed Circular.

Hard circular plates heat easier than soft, and dry lumber causes greater heating than wet.

A taper circular will stand a higher speed than an even gauge or one ground thinnest in the centre, as there is less weight at the rim and consequently less centrifugal force.

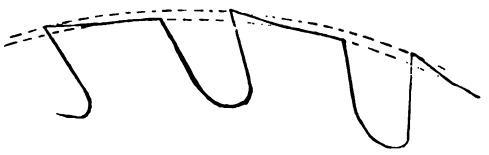


Fig. 86. Knowles' Tooth.

As a slight offset to the advantage that rim tapering gives a circular, there is this: that as the saw gets smaller it gets proportionately thicker, when it does not need as great a thickness to keep it stiff.

Veneer-cutting circular saws are employed for making veneers or

very thin plates, generally of valuable woods.* They are designedly thinner at the edge than in the center, as the sheet removed readily bends aside. They are either solid or segmented. The edge must run exceedingly true, and the teeth be sharp and very faintly set. The seg-

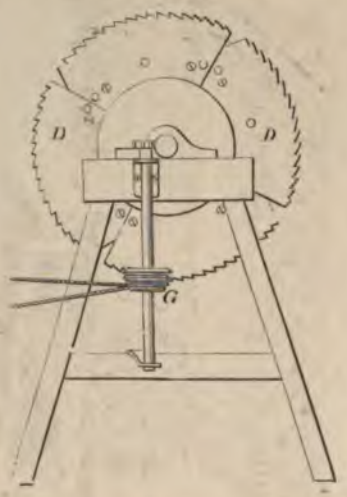


Fig. 87. Small Segmented Circular.

ments are from 5 to 10 gauge, and are 12 inches in diameter.

A smaller segmental saw is shown in Fig. 87; a segment for larger saws is shown in Fig. 88; and a veneer sawing machine in Fig. 89.

While circular saws for wood can be made up to 80 and 100 inches diameter, there are also smaller "circulars" used for such work as

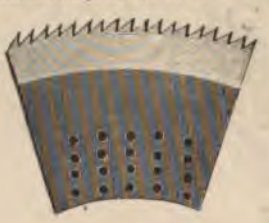


Fig. 88. Cutting Segment of Circular Saw.

Fig. 90. Saw for Gold Pen Slits.

cutting notches in telescopes and in screw heads, slits of bat's-wing gas burners, etc. The teeth of these last are sometimes serrated with a

* Knife or splitting machines for this purpose answer well enough for straight grained and pliant woods, as Honduras mahogany, but not for irregular, harsh and brittle grain, such as rosewood—as in the last case the veneer curls up considerably on removal, and has a disposition to split and become pervious to glue.

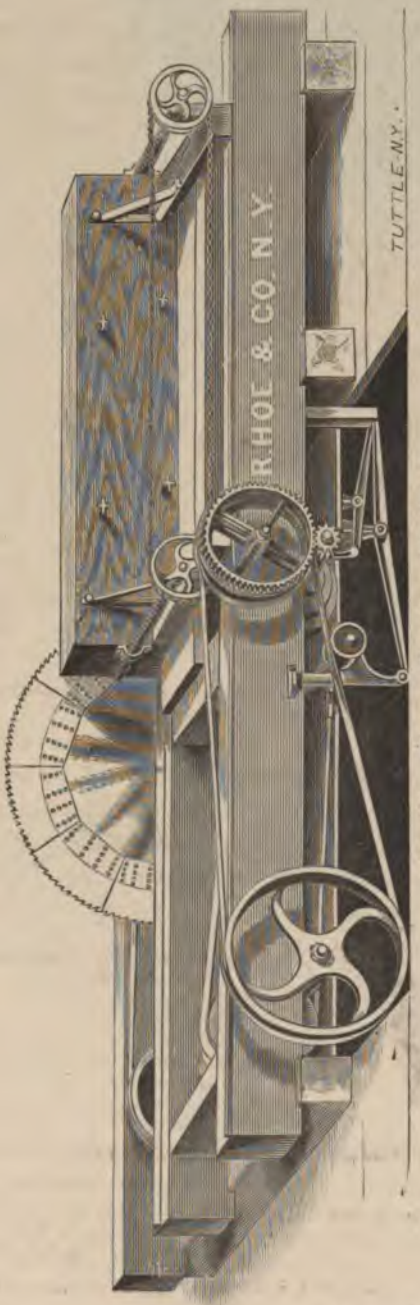


Fig. 89. Veneer Sawing Machine.

screw cutter or tap, as in making the teeth of a worm-wheel. Perhaps the finest circular saws made are those for slitting the nibs of gold pens. The exact size of one is shown in Fig. 90. It is $\frac{1}{200}$" thick, and makes 4000 revolutions per minute. The cut is engraved by using as a transfer the saw itself, kindly loaned by Mr. Eberhard Faber, of New York.

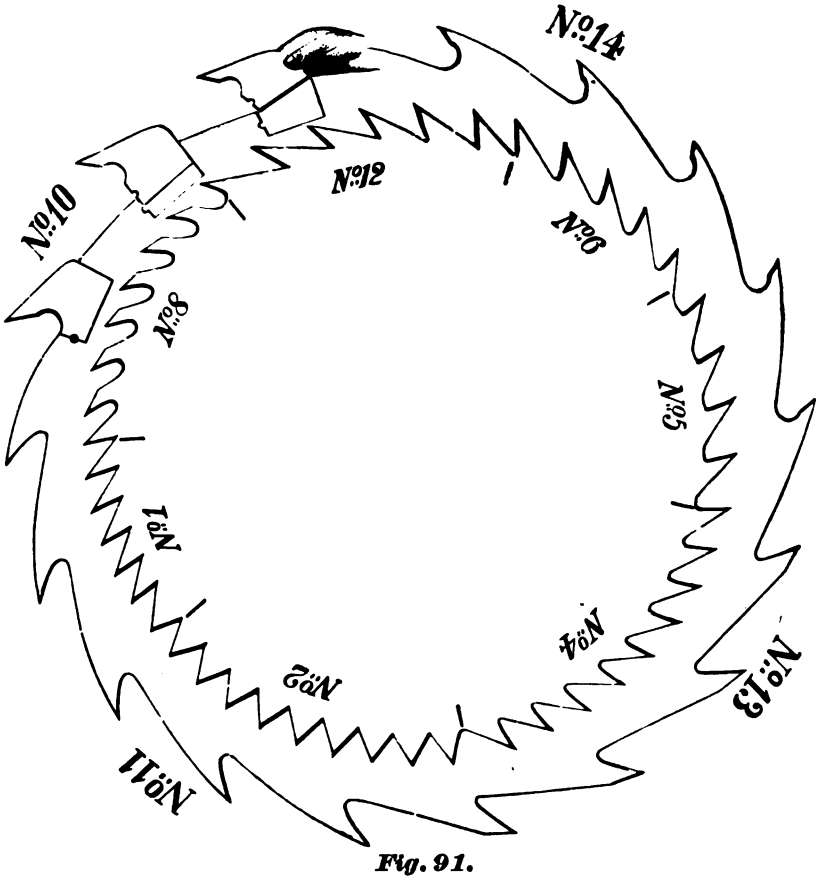


Fig. 91.

Fig. 91 shows various forms of solid and inserted circular-saw teeth, arranged thus by the Disstons for the convenience of customers in ordering.

Referring to the numbers on this figure, Nos. 1, 2, 3 and 5 are for cross cutting; Nos. 6, 8, 11, 12, 13 and 14 for ripping; No. 4 for either. No. 8 is used for hard wood. Nos. 11 and 14 are the most commonly used in America.

A tiny saw, difficult to classify, is Fig. 95, which has two cutting edges, one of which is a reciprocating circular saw.

Fig. 96 shows a surgical circular saw worked by a thumb lever.

For sawing *loaf sugar*, the teeth are ⋁-shaped, one-half inch apart, gauge No. 10, with great set. A 36 inch sugar saw runs only about 300 revolutions and under.

For *ivory* the teeth are ⋁-shaped, 12 points to the inch, with no set. These circulars are 2 to 10 inches diameter, and of from 19 to 22 gauge.

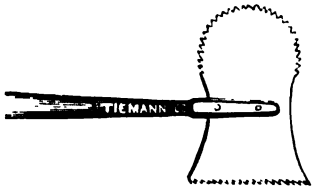


Fig. 95. Bone Saw.

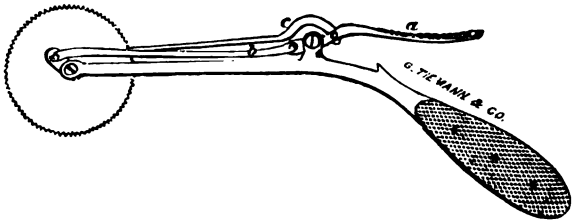


Fig. 96. Surgical Circular. Driven by Thumb.

For *bone* a 9½ inch saw has 100 teeth, "handsaw" style in outline. The plate is 22 gauge, and and an additional $\frac{1}{32}$ inch set is given.

For *iron* the handsaw tooth is used, with no set; space, 12 points; a 4 inch saw of 14 to 22 gauge runs 150 revolutions.

For cutting off wrought iron and steel beams Disstons recommend a circular 44″ diameter and about ¼″ thick, having peg teeth ¾″ apart, with no set, and running slowly where neat cutting is required—say only 150 to 180 feet per minute peripheral speed.

Richardson Bros. say that circulars for wrought iron should have a speed of about 150 linear feet per minute; for cast or malleable iron, one-fourth faster, or say 190 feet per minute.

For *white* or *Britannia metal*, one-fifth the revolutions for wood (say 1800 feet per minute), but a larger tooth than for iron.

For *brass*, as fast again as for iron—say 300 to 375 feet per minute.

As regards the question of few or many teeth for wood cutting, opin-

ions differ, and yet perhaps without cause. The writer inclines to the belief that while the fewer the teeth the higher the feed capable per tooth, and the more chisel-like the action of the teeth,—yet there are cases where by reason of light power and hard cut more teeth are necessary. Certainly thin saws require the most teeth; or, to put it the other way, increasing the number of teeth enables the use of a thinner saw and less power.

Fineness of teeth also gives smoothness of lumber, as the teeth are stiffer and less likely to lead into the wood, and the saw marks are closer together than with many teeth.

In some parts of our Southern States where formerly a 56 inch circular had but 26 to 28 teeth, now there may be found a very large proportion of 56 inch disks with 56 teeth.

The fewest number of teeth we know of in a rotating saw is *two;* these being simply two long arms with a central hub, revolving on an arbor, and chiseling their way quietly and slowly through a log. This could hardly be termed a "circular saw," being rather a rotating chisel, and just as much like the Daniels planer used in car shops.

The following table gives the average diameters and thicknesses of circular saws, with size of mandrel holes:

TABLE II.

Diameter.	Average Thickness.	Size of Mandrel Hole.	Diameter.	Average Thickness.	Size of Mandrel Hole.
4 inch,	19 gauge,	$\frac{3}{4}$	36 inch,	9 gauge,	$1\frac{5}{8}$
5 "	19 "	$\frac{3}{4}$	38 "	8 "	$1\frac{5}{8}$
6 "	18 "	$\frac{3}{4}$	40 "	8 "	2
7 "	18 "	$\frac{3}{4}$	42 "	8 "	2
8 "	18 "	$\frac{7}{8}$	44 "	7 "	2
9 "	17 "	$\frac{7}{8}$	46 "	6 "	2
10 "	16 "	1	48 "	6 "	2
12 "	15 "	1	50 "	6 "	2
14 "	14 "	$1\frac{1}{8}$	52 "	5 "	2
16 "	14 "	$1\frac{1}{8}$	54 "	5 "	2
18 "	13 "	$1\frac{1}{4}$	56 "	5 "	2
20 "	13 "	$1\frac{5}{16}$	58 "	5 "	2
22 "	12 "	$1\frac{5}{16}$	60 "	5 "	2
24 "	11 "	$1\frac{3}{8}$	62 "	4 "	2
26 "	11 "	$1\frac{3}{8}$	64 "	4 "	2
28 "	10 "	$1\frac{1}{2}$	66 "	4 "	2
30 "	10 "	$1\frac{1}{2}$	68 "	4 "	2
32 "	10 "	$1\frac{5}{8}$	70 "	3 "	2
34 "	9 "	$1\frac{5}{8}$	72 "	3 "	2

(In Appendix X, the gauges are given translated into decimals and also into thirty-seconds of an inch.)

In times past the grinding process was so difficult and expensive that the flat "circular" was finished on the log side only. Nowadays

Fig. 97. Dished Circular.

many makers give the same accurate finish on both sides, and the saws can consequently be used either right or left "handed.."

A variety of the circular saw is the *dished* circular, used not for dividing material in a right line, but for cutting out beveled-edged disks, as barrel heads. Its action thus comes in between that of the circular and that of the cylinder saw.

Concave saws run about the following diameters and gauges:

6 inch,	18 gauge.	12 inch,	15 gauge.
7 "	18 "	14 "	15 "
8 "	18 "	16 "	14 "
9 "	17 "	18 "	13 "
10 "	16 "	20 "	13 "

Figs. 98 and 99 show "right-" and "left-handed" saws sufficiently clearly to require no other explanation.

Inserted-toothed circular saws, the use of which is already large and rapidly extending, have the following advantages over solid:

The teeth being drop-forged, from bar steel, are regular in size and shape, and of better material than is possible to use for the whole saw.

The teeth are capable of having more and better shaped throat—a

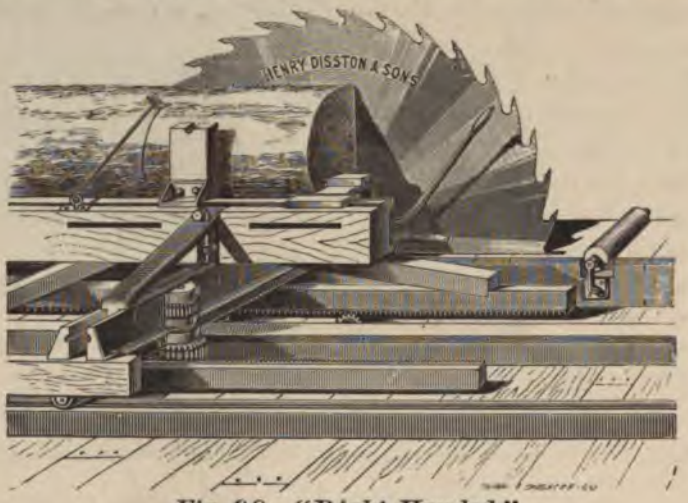


Fig. 98. "Right Handed."

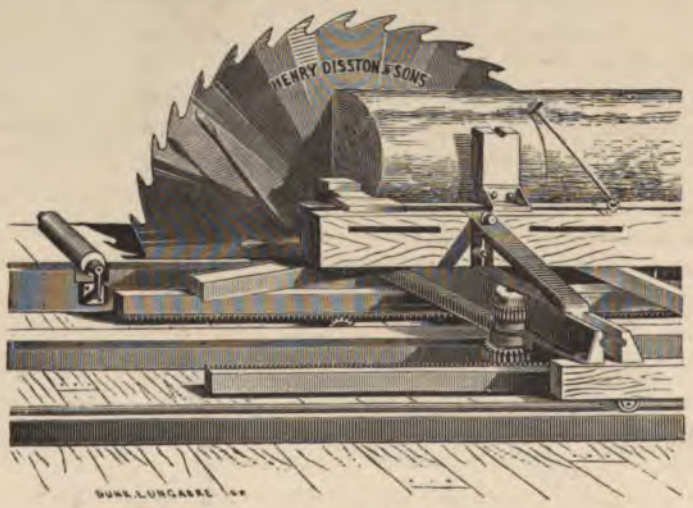


Fig. 99. "Left Handed."

special advantage for coarse feeds, and for soft, wet and fibrous woods.

They cut so much smoother lumber that they are frequently spoken of as "planer-bits."

They effect a great saving in time and files and blades, over gumming and sharpening; they also avoid lessening the capacity of the saw by the reduction in diameter consequent on filing the solid saw.* The widely-operating and successful use of emery wheels is, however, lessening this advantage.

The time of the mill lost while the solid tooth saw is being re-gulleted is important in new countries and in locations far from the saw factory—as New Zealand.

With a few thousand little "bits," costing three cents each, a New Zealand or far Canadian sawyer is independent of mishaps, even with the knottiest wood.

There is an avoidance of the necessity of readjusting and aligning

---

* COST OF RUNNING PLANER-TOOTHED SAWS, AS COMPARED WITH SOLID-TOOTHED SAWS.—Messrs. Emerson Smith & Co. give the following calculations:

"The average size of board circular saws is about 56 inches in diameter, so that we will base our calculations on that size.

"Circular saw mills vary in capacity from 5000 to 40,000 feet of lumber per day, 10,000 feet being about the average.

"Starting with a new 56 inch saw, at 10,000 feet per day, we will base our calculations on sawing 1,000,000 feet in 100 working days, or about four months.

Cost of 56 inch solid saw, present price list	$117 00
One hour per day for filer, 100 days, thirty cents per hour	30 00

"In order to reduce the size of a 56 to a 54 inch saw, a strip of tempered steel, 14 feet in length, 1 inch in width, and the thickness of the saw, must be filed into fine dust. Besides, time is spent in spreading and setting the teeth and in rounding the saw.

1 dozen 14 in. mill files, per month, at $9 per doz	$36 00
Gumming and straightening once in 2 months, say	15 00
Average cost of transporting to saw maker, say	6 00
Reduction in size of saw, say 2 inches, leaving the saw at the end of 4 months 54 inches in diameter, present price list, $96, reduction in value	21 00

"The above calculation only estimates the reduction in the size of the saw at one-fiftieth of an inch per day. If the saw is kept gummed down with a file, the cost of files and filing will be much greater than this estimate. If a gummer of any kind be used, add cost of the machine, wear of tools, wheels, etc., and the owner will find the cost more than the estimate of sending it to a saw maker.

Cost of mill standing idle, say half hour per day, in filing and putting saw in order so that the owner has lost the sawing of 500 feet of lumber per day, at $2 per 1000 cost of sawing for 100 days	$100 00
Total cost	$325 00
Cost of planer, saw and 1000 bits	200 00
Difference in favor of Planer Saw	125 00

the saw on the mandrel in the case where a spare saw enables the sawyer to save the otherwise inevitable stoppage of the mill in the case of a tooth breaking.

The spacing, set, and shape of the inserted teeth is better than the average sawyer would maintain even with the "guide lines" marked in the disk by some enterprising makers. (See Fig. 100.)

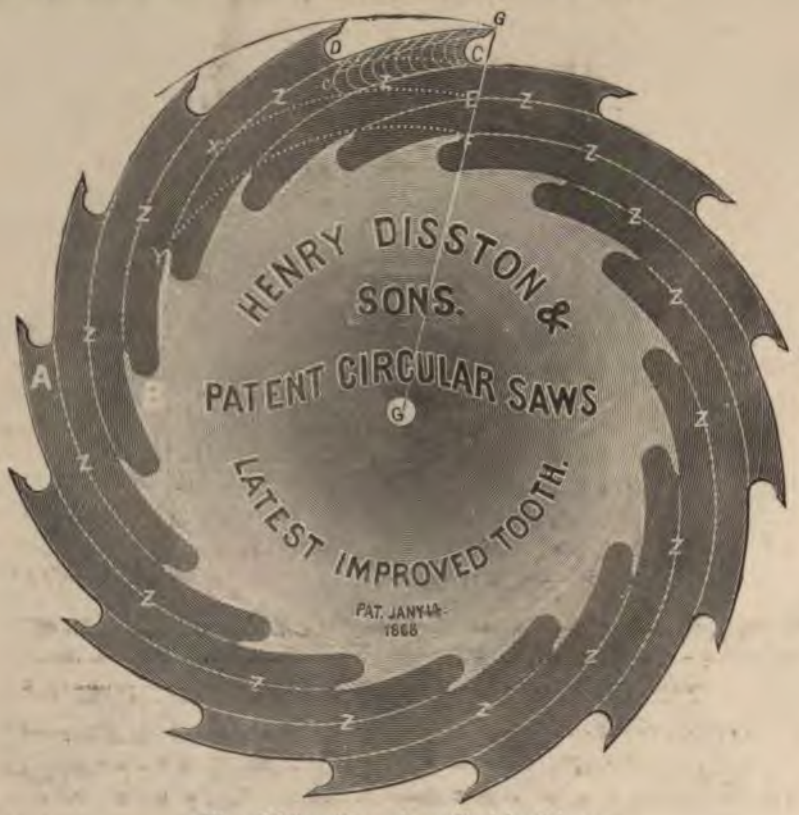



Fig. 100. Showing Guide Lines.

Men capable of putting solid saws in order are very scarce. But in many mills are to be found men who are good, valuable sawyers, and understand turning out lumber to the best advantage, but who are poor filers. The inserted tooth makes their skill available.

The plate of a saw is nothing but a handle carrying the teeth, and is strained by the use of dull teeth. The inserted teeth can be kept sharp and hence strain the plate less.

The cutting points or saw bits being shaped and sharpened while out of the saw, can, if it be the sawyer's fancy, be made slightly concaved on the under side, thus presenting full prominent corners a little in advance of the cutting centre; and in consequence of the corners of all teeth wearing faster than the centres the separate teeth will do more work with one dressing, than solid teeth, which are filed or dressed square. Fig. 106 shows their first state and mode of

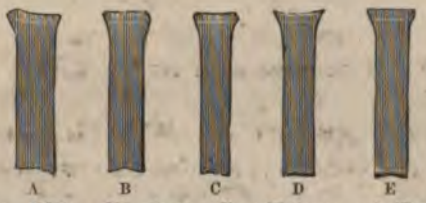


Fig. 106. Various Conditions of Teeth.

wear. They represent a top view of the points of teeth in various shapes. If the point of a tooth get into the shape of A or any other irregular shape, it should first be squared and filed up into a regular shape, so that there will be an equal amount of metal on each corner. If a tooth loses a corner like that of B, the opposite corner

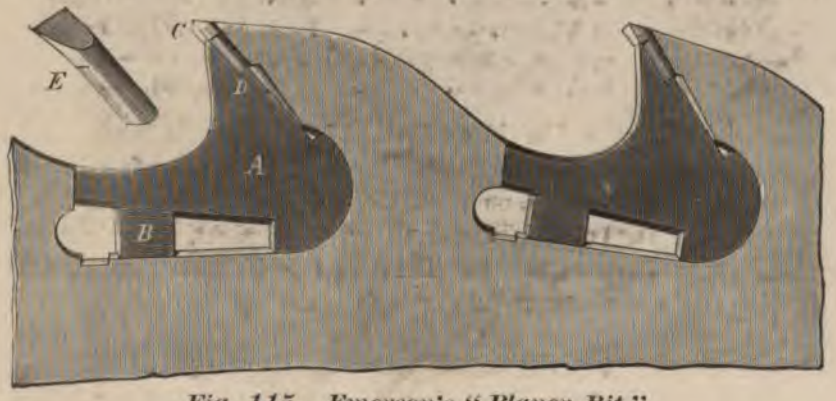


Fig. 115. Emerson's "Planer Bit."

should be filed off so as to have the appearance of C; swage it into shape like D, then bring it into a proper shape like E. A is also a bad tooth, having too much metal in one corner, and must be filed into the shape of C before it will spread properly.

One file will go as far in keeping a good inserted tooth saw in order as ten with a solid saw.

An inserted-toothed saw can have hard or soft teeth at will, for varying kinds of lumber.

The Emerson bits are tempered to scratch glass, and weigh one-sixth ounce each.

The various items of power-saving by reason of keenness of cut and narrowness of kerf, are the same as are fully laid down on another page.

Inserted saw teeth came into use about 1840, the teeth being placed in rectangular sockets and held in place by a \/ tongue and groove. The rectangular sockets have been largely discarded for curved, as giving less liability to crack.

The following figures from the Albion Mill on our West Coast, show the performance of the Hoe chisel bit saw: See Fig. 107.

	No. days.	Feet Board Measure.
November,	26,	859,407
December,	23,	798,274
January,	26,	866,992
February,	25,	852,818
March,	25,	962,537
April,	26,	934,337
May,	10,	387,019
	162,	5,661,385

Number of bits used in the work, 4000 in all.

The bits are run in the Albion Mill as follows: Starting in the morning, with new teeth, on 4 inch feed, in hard pine or red-wood until noon. Then a set of new teeth run until night. At night the watchman puts in the next set. The dulled teeth are sharpened twice for the bottom saw and are then worked in the top saw.

The "Brooke" tooth saw is shown so clearly in Fig. 108 as to require no special explanation.

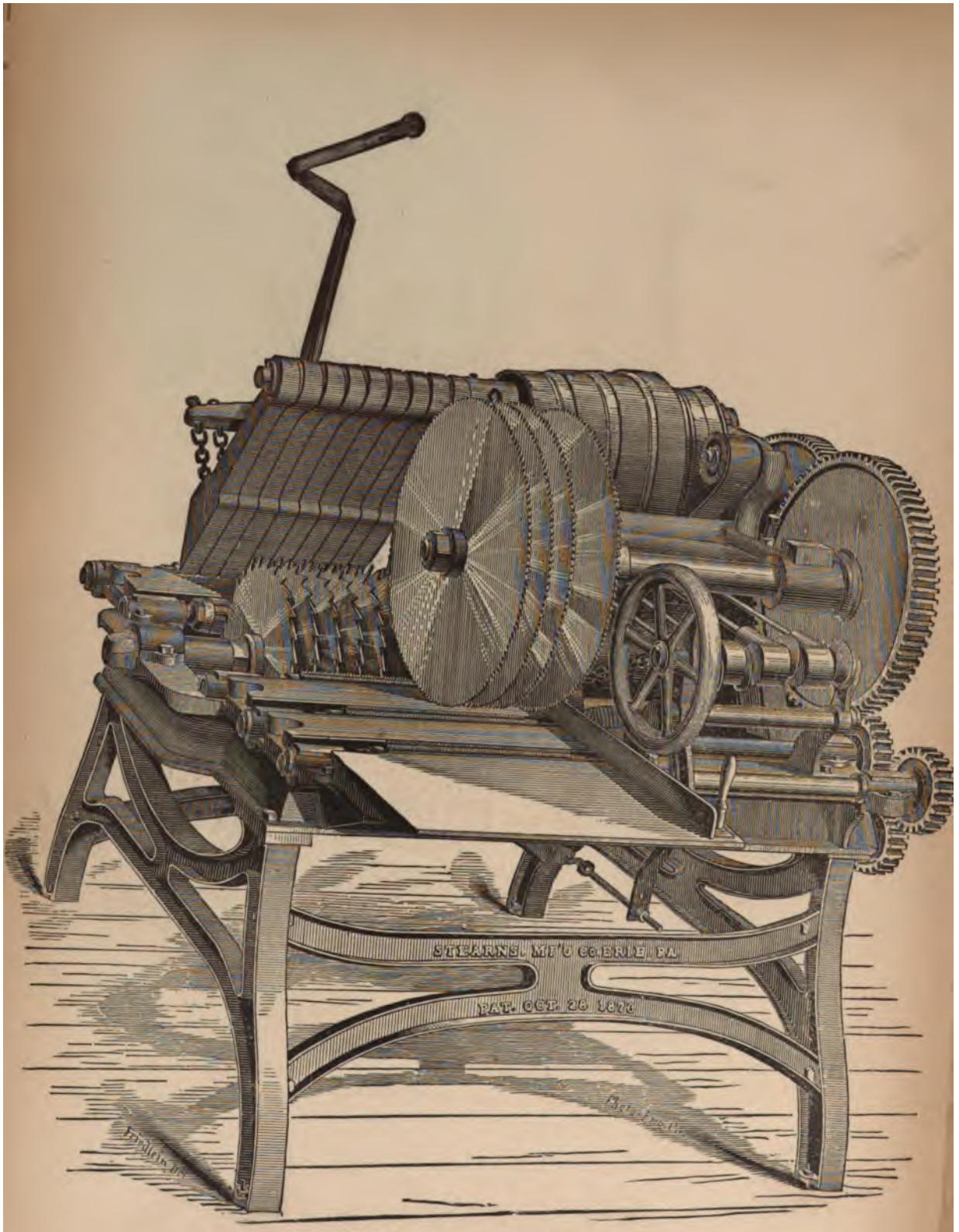
Fig. 109 shows the cutting action of an inserted toothed saw. The type shown is one of those made by the American Saw Company.

Fig. 110 shows the "movable tooth" of the American Saw Company.

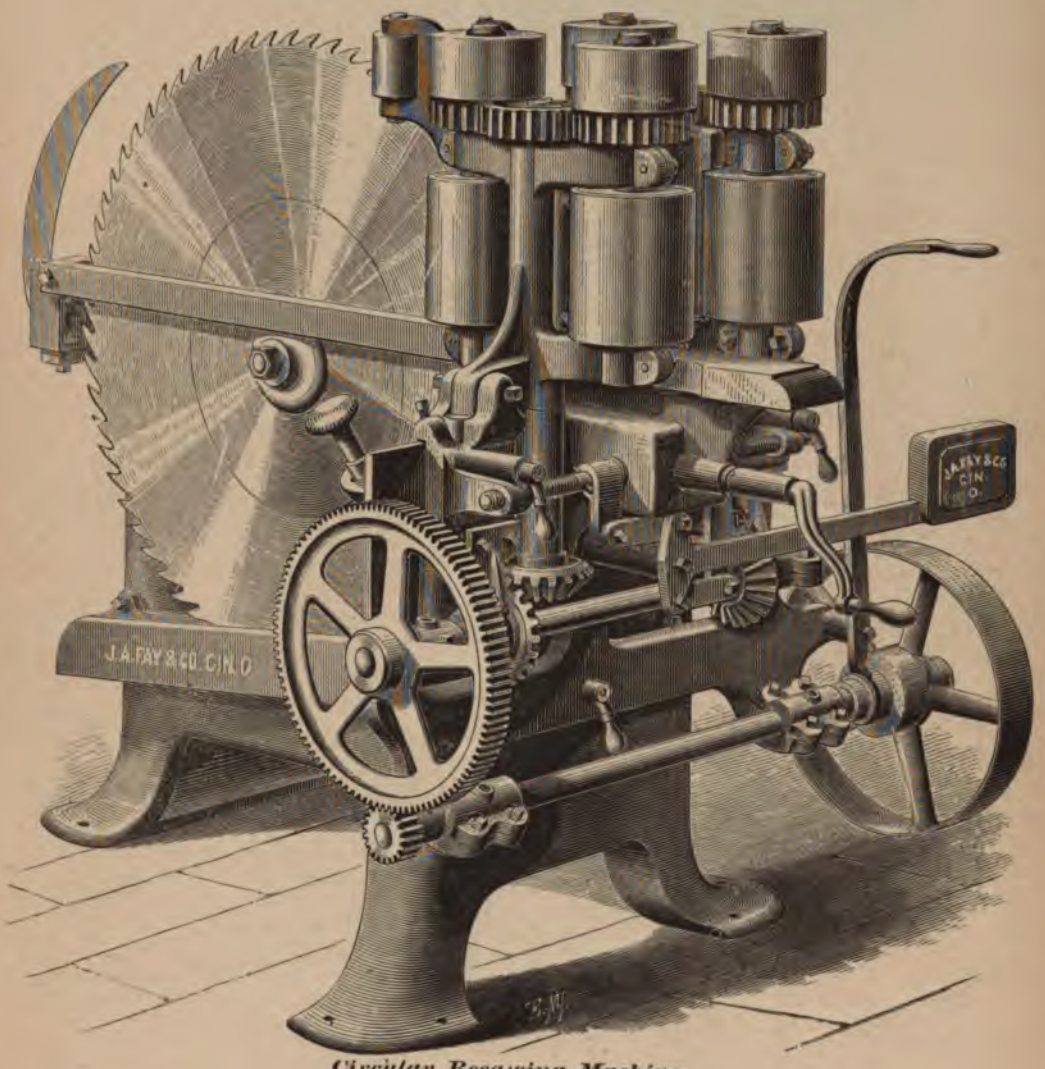
Fig. 111 shows a "perforated" inserted tooth made by the last-named makers.

Inserted toothed saws are made from 13 to 6 gauge and from 12 to 72 inches in diameter, the smaller sizes being used for edgers and gangs.

Stearns' Rossing Machine.



Eight-Saw Lath Bolter.



Circular Resawing Machine.

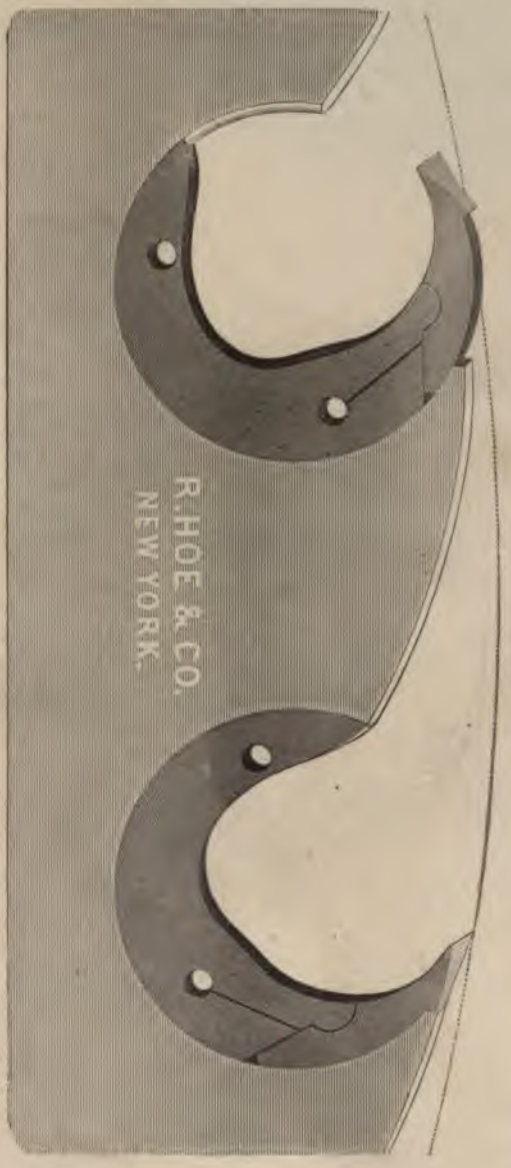


Fig. 107. "Chisel Bit" Saw.

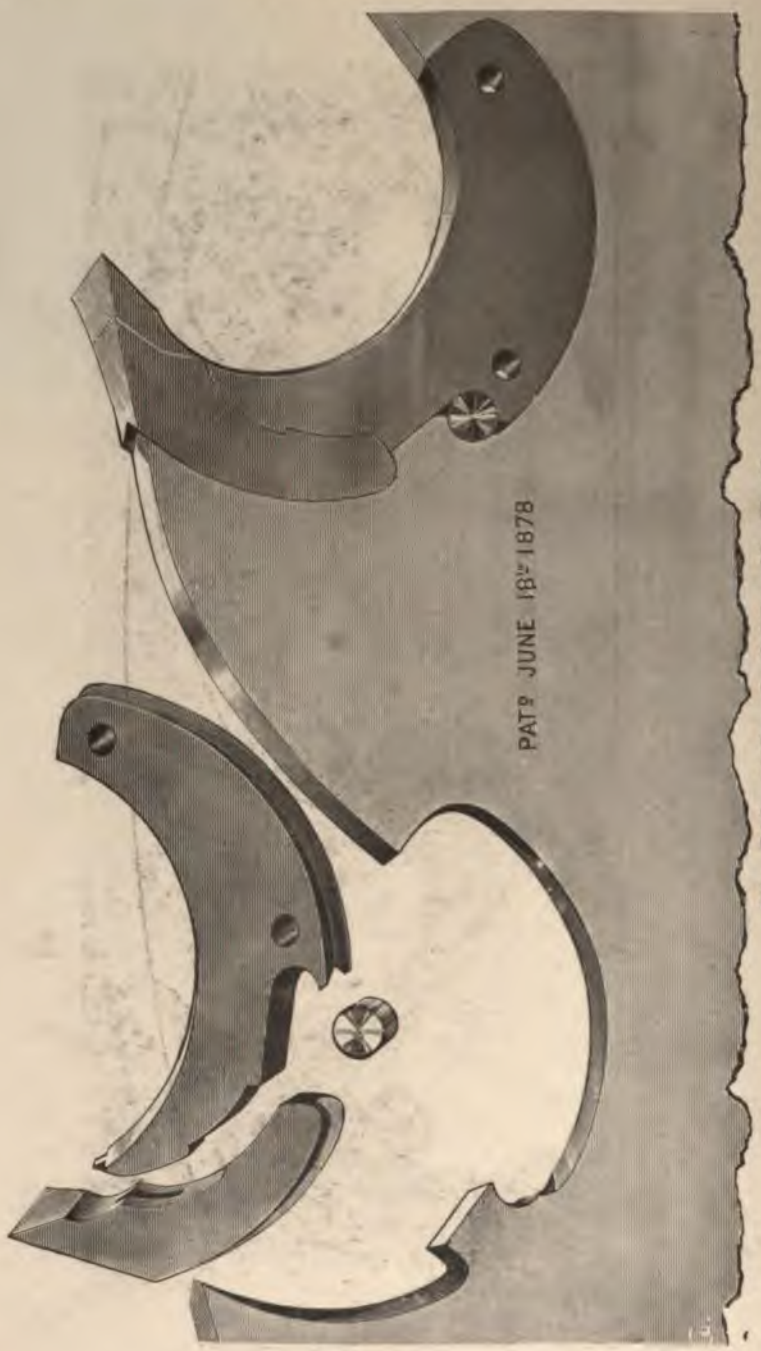


Fig. 108. "Brooke" Movable Tooth.

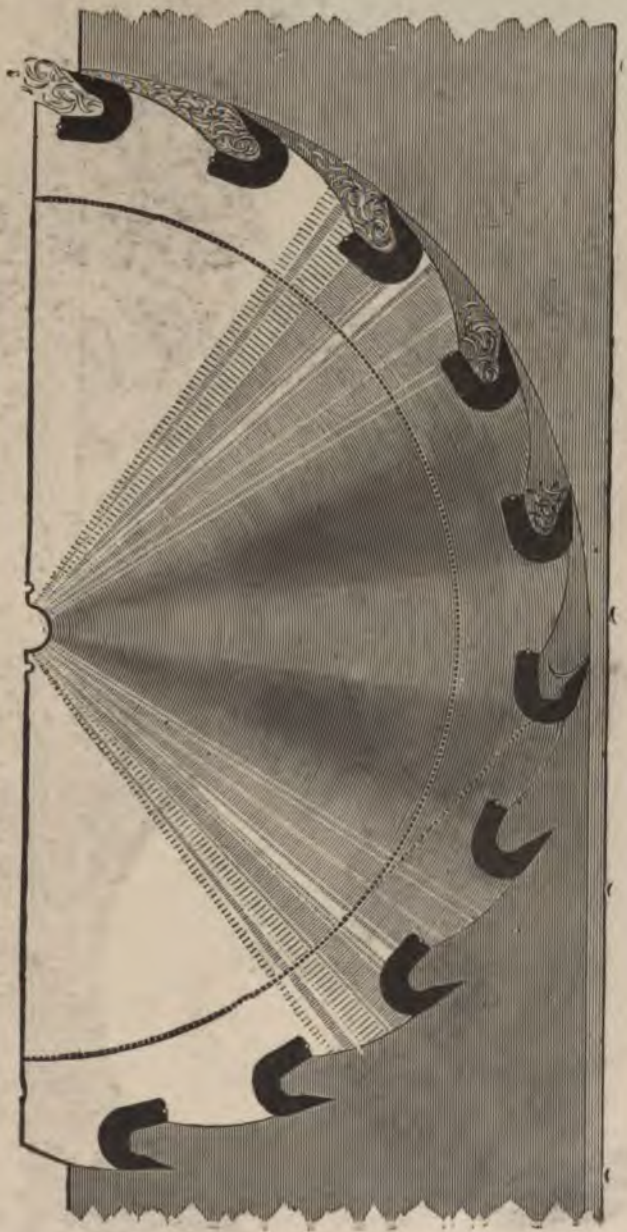


Fig. 109. Cutting Action of an Inserted Toothed Circular Saw.

Fig. 111. Perforated Inserted Tooth of the Am. Saw Co.

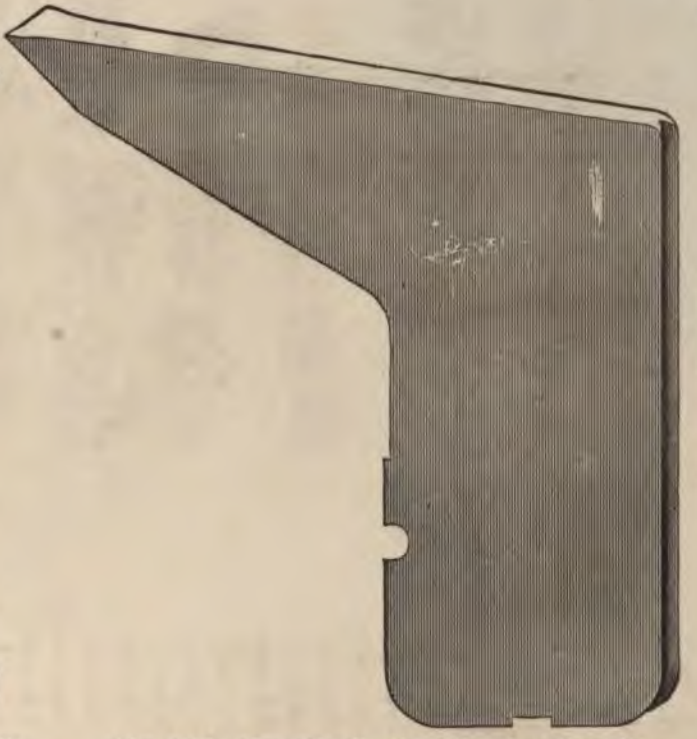
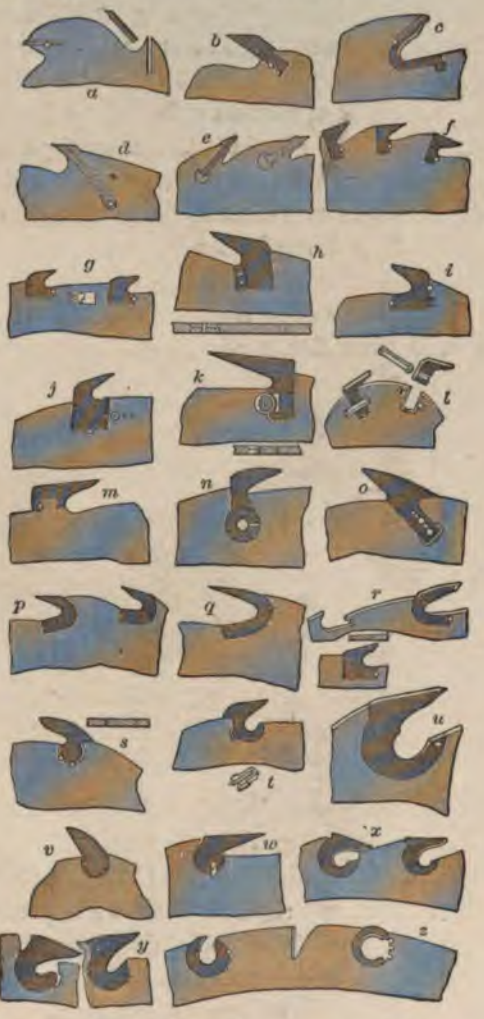


Fig. 110. Movable Tooth of the Am. Saw Co.

From "Knight's American Mechanical Dictionary"* we take the annexed concise representation of various insertable teeth:



a. Krauser.
b. Colsen.
c. Emerson.
d. Clemson.
e. Lippincott.
f. Spaulding.
g. Emerson.
h. Neale.
i. Emerson.
j. Brown.
k. Clemson.
l. Woodruff.
m. Emerson.
n. Disston.
o. Shoemaker.
p. Emerson.
q. Emerson.
r. Emerson.
s. Disston.
t. Disston.
u. Hoe.
v. Strange.
w. Humphrey.
x. Miller.
y. Disston.
z. Miller.

The most remarkable sawing of which we have any record was done in September, 1879, in the mill of Messrs. Chapin & Barber, Bay City, Mich., with a "Lumberman's Clipper" (inserted teeth) saw made by Emerson, Smith & Co., of Beaver Falls, Pa., and run by A. G. McCoy. There were made nineteen cuts, each 16 feet long

* Houghton, Osgood & Co.

and 23 inches wide or deep, in *one minute* of time. Material, white pine. The saw was 72 inches diameter; No. 6 gauge at centre, 7 at rim, and containing 72 cutting teeth. It ran at the rate of 650 revolutions, or about 12,250 feet per minute (over two miles!) and cut 12 inches at each revolution. This extraordinary rate of feed was effected by steam; *i. e.*, a steam cylinder, 38 feet long, and 7½ inches diameter, has its piston attached to the carriage so that a log 16 feet long was forced through its entire length in a trifle over one second—instantly the stroke being reversed, the carriage returns in about a second; one jerk with a lever by the "setter" or man who rides on the carriage, and the log is "set" for an inch board, and the saw is entering it again.* "What becomes of the sawdust?" may be asked by some—as no saw would have throat room sufficient to contain one-tenth of it. It

Fig. 116. Lumberman's Clipper.

crowds back past the edge of the saw, mostly on the board side—the board yielding or deflecting, and thus opening a large space for its reception and discharge. If the lumber sawed be say 2 inches thick or over, and too rigid to yield to the pressure of the sawdust, no such feed can possibly be maintained; nor if the saw be cutting through the centre of a log, where no deflection can take place. In these cases the feed of the carriage or log must be graduated to the capacity of the dust chamber or throat room of the saw.

The teeth or attachments of an inserted teethed "circular" should be made perfectly secure, so as to obviate any danger of their flying out while the saw is in rapid motion, and endangering life and doing damage to saw or machinery. If the attachments are not secure the tooth

* This is familiarly known as the "shot-gun" feed.

is liable to fly out, without a moment's warning, like a bullet (see *Scientific American*, Oct. 11, page 279).

A curiosity in the way of a circular saw is shown in Fig. 117; there being two planer bits inserted (projecting sidewise, of course), to clear off the roughness left by the cutting teeth. We have at hand no record of its actual performance.

To lessen the heating of circular blades, and to prevent wabbling being caused by expansion, a patent circular saw has radial slots terminating in round holes—the office of these being to prevent cracks from extending. See Fig. 118.

Fig. 117.

Lockwood's idea is that if a radially slotted saw be heated at or near the eye, the slots close up as much as the metal expands, thus leaving the edge of the saw entirely unaffected. Or, if the edge of the saw be heated and consequently expanded, the slots, by opening, neutralize the expansion, and both the eye and the edge remain true. A saw never or very rarely becomes heated enough to injure the metal or the cutting capacity of the saw; and the makers claim that with this

improvement, a saw will run equally true and make lumber equally well, whether the saw is hot or cold, and will never require straightening. The makers also claim that the lumber, with the improved saw, is truer and smoother than has heretofore been made with circular saws.

They explain its action as follows: When it runs out of the log, the log, in passing, presses hard upon the outside of the saw near the eye or within the range of the slots, and by the friction thus produced, the saw becomes heated in that part, and consequently expands, whereupon the sections close up the slots and project inwards, and thus release the saw from the great strain on the edge, which a solid saw must endure before it dishes. When, on the other hand, the saw runs into the log, there is great strain thrown upon the edge of the saw by

Fig. 118.

cramping it in the guides, and hence the heating on the outer edge and consequent expanding of that part, which renders the saw loose and flabby and uncertain in its operation. They claim that a slotted saw may be heated ever so much or often, and never be thereby thrown out of its true surface; the external and internal vent allowed by the slots causing the saw always to operate easily and freely, and consequently be less liable to heat; and if it does heat, no bad effect is produced, nor any uncertain operation caused thereby. They say: "A slotted saw will invariably run where the filer desires, every time in the same track, unless violently restrained. If the saw does not run where you want it, correct it by filing. In consequence of their being no effect produced on the accurate operation of the saw by heating or

changing the temperature, a saw can be run with equal certainty and as effectually as a solid saw, with a gauge less set. A slotted saw will therefore save fully one-third of the saw scarf, and ten per cent. of the lumber when sawed into boards. A slotted saw will never spot, because, however much it may be heated, it will resume its original shape when cooled."

One device for cooling the saw and preventing cracks from extending far, is a number of round holes drilled obliquely through the plate, and intended to cause an air current through the disk.

It is estimated that three times re-gumming a non-perforated circular costs nearly the price of a new saw. Perforations in the line of the gullet lessen this cost. The metal in the track of the perforations is softer than the teeth, because of the sawdust left in them when the plate is scoured after tempering burns when the plate is flattened and draws the temper of the holes.

Spaulding states that the bevel on the under side of his inserted teeth should range down on an angle to one-fifth the diameter of the saw.

In cutting 32-inch stuff, with a feed of $\frac{1}{16}$ inch to each tooth, it is evident that there must be a throat area of *at least* 32 x $\frac{1}{16}$ = two square inches.

Spaulding computes the necessary throat room thus:

A 72-inch saw with 46 teeth, cutting 4 inches per revolution, removes 128 square inches on a full cut of a 32-inch board. This solid wood cut into dust will require twice the space, or 256 square inches; hence each tooth should have $5\frac{1}{2}$ square inches throat room, to work freely and easily and clear freely. With less throat it will clog or force the sawdust into the space between the saw and the log, and cause it to heat on the rim.

In cutting thin boards which will bend aside, perhaps less throat is required. See performance of A. G. McCoy with a 72-inch saw taking 12 inches feed on a 23-inch log.

It is stated that the Spaulding inserted teeth will stand $\frac{1}{12}$ inch to $\frac{1}{8}$ inch feed to the tooth and have room for the dust.

Disstons have a patent on enlarging circulars which have been worn down to unavailable sizes, by means of segmental rims of teeth, the periphery of the old plate and the inner edges of the segments being halved together and secured with rivets. A four-foot plate may be pieced out to 5 or six feet. The expansion of the rim in running is

said to be checked at the joint and not to affect the main plate. The old plate is grooved on each side to a gauge less in the centre than at the rim.

By the use of an "adjustable cone bushing," saws of varying-sized holes can be used on different arbors.

THE CYLINDER SAW has many names, forms and applications, all having cylindrically curved edges cutting parallel to the axis of the cylinder. Perhaps its oldest form is the Trepan or Trephine saw (Fig. 125), of the surgeons; also called a *Crown* saw, and used for removing circular pieces of bone from the skull. This is also misnamed the "spherical saw." The button saw has a similar shape, and is used to cut out the circular blanks of bone or pearl buttons. As the barrel or tub saw, it is used to saw barrel or tub staves on the curve; in this case its functions being not to remove a circular disk, as in the trepan or button saws, but to produce a longitudinal segment of a hollow cylinder. A similar saw is used for sawing wooden water troughs and

Fig. 125. Trephine.

sections of wooden water pipes. Tube saw is another name for this class. Fig. 126 is a fair illustration.

The cylinder saw comes into play nicely where the waste of a saw mill is to be sawed into staves, as in the Baltic country.

The main barrel of the saws is not hardened; the teeth are on a band a few inches wide, soldered on. The grinding and balancing has to be most exact, and it is generally necessary to finish the saw on the spindle on which it is to be run, and not to remove it afterwards.

For cutting out staves for tight barrels and casks, cylinders 40 inches long and 24 inches diameter are used.

The cylinder saw has also been made reciprocating in its action, to permit cutting very long segments. As the piece removed by a cylinder saw passes inside the band, it is evident that there can be no arms to stiffen the cutting edge if the rotary action be continuous; but by making the teeth double-acting and giving the cylinder only a quarter or a fifth rotation, and this reciprocating, a segment of considerable width and of unlimited length may be removed.

THE BAND, BELT, OR RIBBON SAW, although conceived as early as 1808, by Wm. Newberry (for splitting *skins* and wood), is of comparatively recent general introduction, having laid for forty years as a curiosity—it being supposed impossible to join the blades properly—and has not yet reached that wide application for heavy work to which its many merits entitle it.

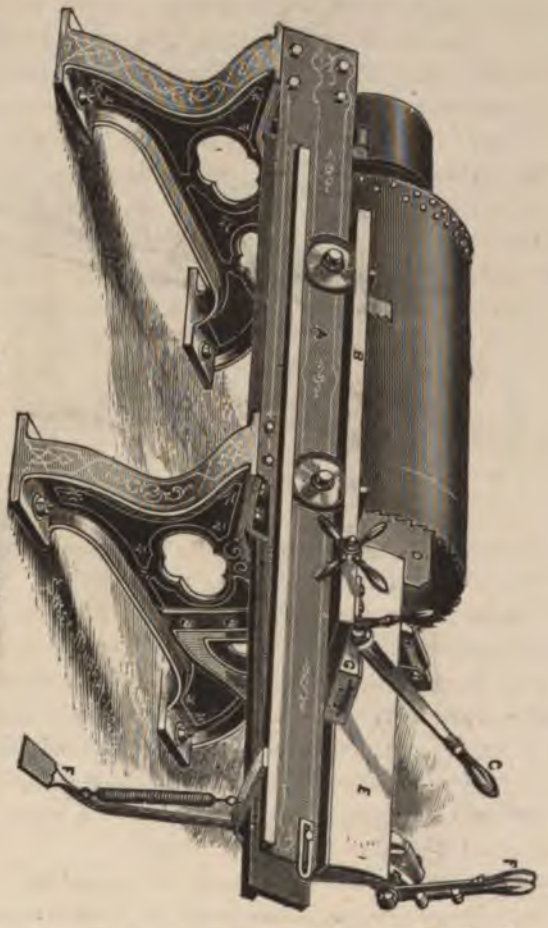


Fig. 126. Cylinder Saw.

The machine of seventy-two years ago contained all the essential features of the modern machines. We illustrate it herewith, by kind permission of Messrs. London, Berry & Orton, of Philadelphia.

As we now know the band saw it is a thin, flexible, endless band of steel, serrated on one edge, and passing over two large straining pul-

leys, in the same plane and with parallel axes, the rotation of which gives it motion through a supporting work table. The teeth are protected, and the blade given greater "grip" on the pulleys (lessening slip) by a rubber or leather tire. One maker obviates the destruction of tire and teeth, when the lower wheels are stopped by the brake, by having false over-tires of steel covered with leather, slipping on the main tire.

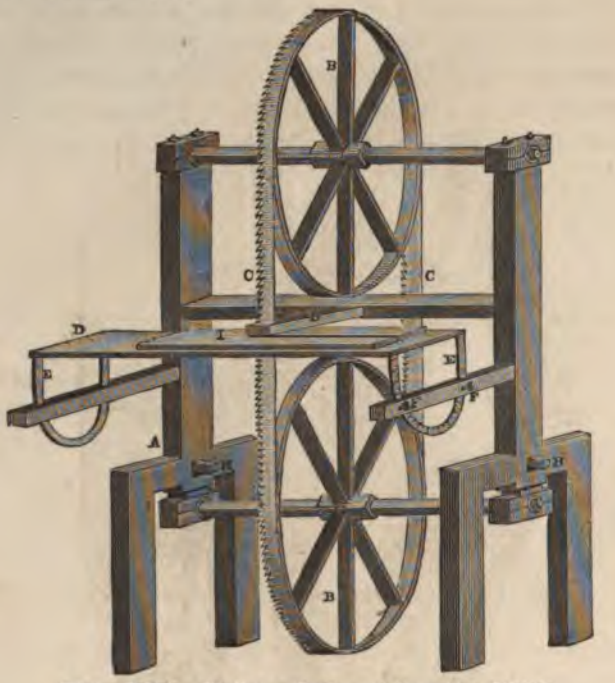


Fig. 127. Original Band Saw of 1808.

The construction of the blades offers a paradoxical problem. They must be soft and flexible to pass readily around the pulleys at a light speed, without breaking; and yet they must have hardness sufficient to receive and maintain a keen cutting edge, and stiffness enough to resist somewhat firmly the pushing and bending tendency of a high feed.

As in many other branches of industry, the demand for a product at first deemed difficult or impossible to make, has been nobly met. The material for the blade has been produced and worked; and the many disheartening difficulties and failures in the machine itself have been overcome. Experience and inventive genius have surmounted the

obstacles interposed, and to-day the band has almost entirely superseded the reciprocating saw for scroll work and is fast encroaching upon the circular, single sash and mulay for resawing; while strenuous efforts are being made to force its use for log-sawing. It offers for ship timber cutting the best advantages of the circular in smooth or continuous action in a right line; and that of the scroll or "jig" in capacity to saw at any angle, curve, or bevel.

Like the circular saw, its continuous motion admits of very high speeds, and there is no non-cutting return stroke. One of its principal advantages, also, is its immunity from heating, there being but a proportionally small portion of its length (say two or three per cent.) in frictional contact, and this being cooled by rapid passage through the air.

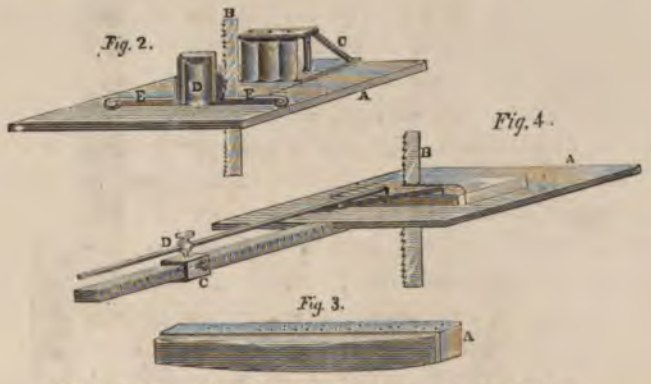


Fig. 128. Details of Newberry's Machine.

One good feature is that the sawdust is constantly carried down; it requiring no blower as does the jig, to prevent clogging and enable the workman to see the line he is cutting to. A very simple adjustable device enables it to be kept in line by slightly varying the position of one of the pulley axles. It should by its superior steadiness scratch less stuff than the circular.

No matter what the speed, the tension of the band remains about the same—as is not the case with the circular. It is, too, easier guided than the latter, while having less necessity for guidance. These properties tell in the market price of lumber, as well as in the quantity of planed lumber a given log will make.

Perhaps its main advantage is in its narrow kerf; saving time, material, and power and giving increased duty.

As the office of a saw is to sever by removing or wasting material, the thinner it can be had, the more economical of time, power and material.

We may estimate that the kerf waste (outside the employment of the best gang saws in "deal frames") is as high as 20 per cent., or one-fifth. Indeed, if we consider the American mills, which turn out stuff principally as one-inch boards, the waste with careless sawing is as much as 25 per cent., or one-fourth.

The circular and mulay often making $\frac{5}{16}$ inch kerf, which is increased to $\frac{3}{8}$ inch by scratches and by irregularity of line, we have only $\frac{5}{8}$ lumber for $\frac{3}{8}$ kerf; or $37\frac{1}{2}$ per cent. loss, in material alone. As every $\frac{1}{16}$ inch in kerf saves 1000 feet of lumber in each 16,000 feet sawed, any mill cutting on an average 16,000 per day, will save 26,000 feet of lumber per month, or more than the entire expense of running the mill. The loss of power is in most places directly important, and where not so by reason of cheapness or free cost of fuel or of water power, the lessened duty of the mill is an item.

To this may be added labor of the sawyer—who finds it necessary to dog more logs to produce a given amount of lumber, than if thinner and smoother kerfs were made; and also takes more time to cut a given quantity with the thicker and slower-running blades. This figures up in the wages account per thousand feet of lumber made.

The saving in power is not directly as the width of kerf, as the band has more of a scraping action than the circular and takes more power per given width of kerf.

If we consider kerfs running from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch, on inch boards, and see how many boards can be got out of a balk of a given size, with each kerf, this question of waste of material is very plainly brought to mind.

The band saw is the straight blade, rolled in a hoop, and cutting continuously. The circular is the same blade developed in the other plane, into a disk. The band meets each fibre of a log at the same angle. The circular meets those on the top less at a right angle than those at the bottom. As the top segment of one-third the diameter of the circular has more than one-third the semi-periphery (see Fig. 130), it follows that, with a given size "cant" to be cut, the circular has more tooth line to cut the same height of wood than the band has, and this is often an advantage, as the more teeth the less throat room required. Thus the circular, which has greater facility for having throat room

than the band has, requires it less for a given size of tooth and height of cant.

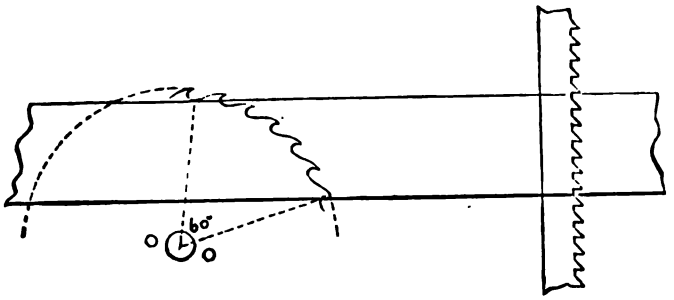


Fig. K. Cutting action of Band and Circular Saws Compared.

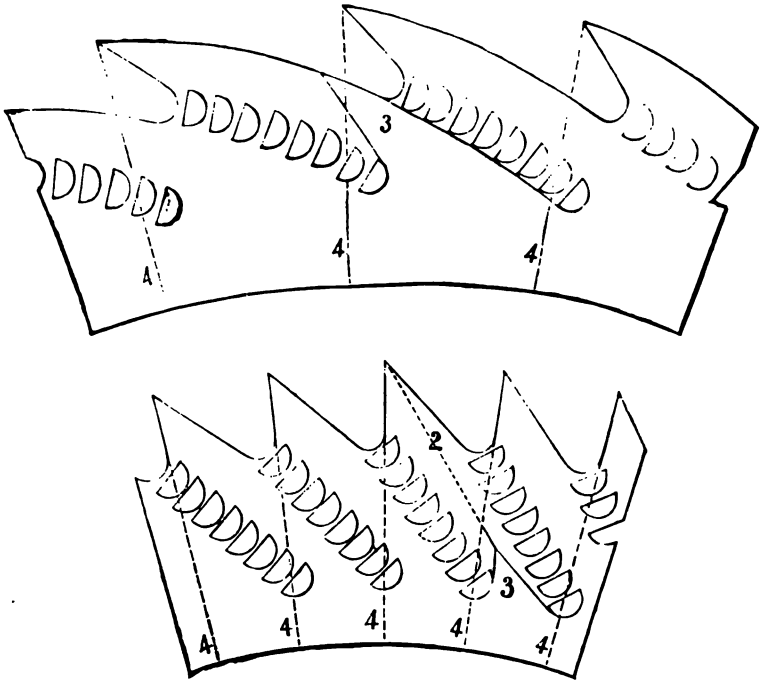


Fig. 129. Perforated Circular Saws.

Fig. 129 show these perforations in the line of future gullets, as made by the American Saw Company.

All the teeth of the band meet the fibres of the wood at the same angle. Those of the circular meet them at a varying angle. Moreover the angle at which any tooth of the circular meets the log is much

more acute than that at which the band saw teeth strike it. This gives a greedier cut and more of a cutting than a scraping action.

Mr. Pryibil, of New York, conceived the idea of giving the band saw a more acute angle with the wood (see Fig. 130); and with this aim, tilted thetable of a band saw about 23½°, and fed a board up hill to meet the blade. Testing the traction of the cutting at a right angle and at the 113½°, he found the feed about one-third easier in the latter case.

The band saw must have spring set, as swaging would stretch and crook the blade. Spring set of course gives a blade less capacity than swaging does, as a swaged tooth cuts on both sides of the blade, and a spring tooth on but one. For small curves it requires more set than for large. It is better at cross-cutting than at ripping.

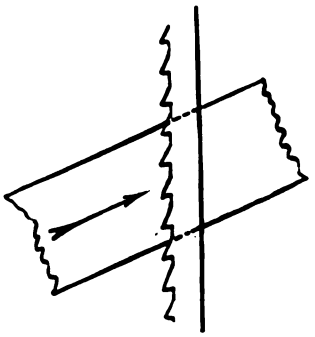


Fig. 130. Feeding a Band Saw Up Hill.

It requires skill to dress and operate it. Although its fast feed and coarse cuttings call for comparatively large throat room, with ordinary tooth spacing, the teeth being necessarily short, it is not capable of having sufficient throat room for coarse feed, and hence it *packs*. This may be obviated by increasing the distance between the teeth — which lessens the duty of the saw.

As the blade is so extremely thin, the tension is difficult to keep; changing instantly with the temperature and requiring special elastic or weighted tension devices to prevent it breaking by cooling down after working.

Too coarse a feed causes the back to be crowded and get longer, like the edge of a leather belt that runs rubbing against a shifter.

The friction against the guides tends to crystallize and crack the

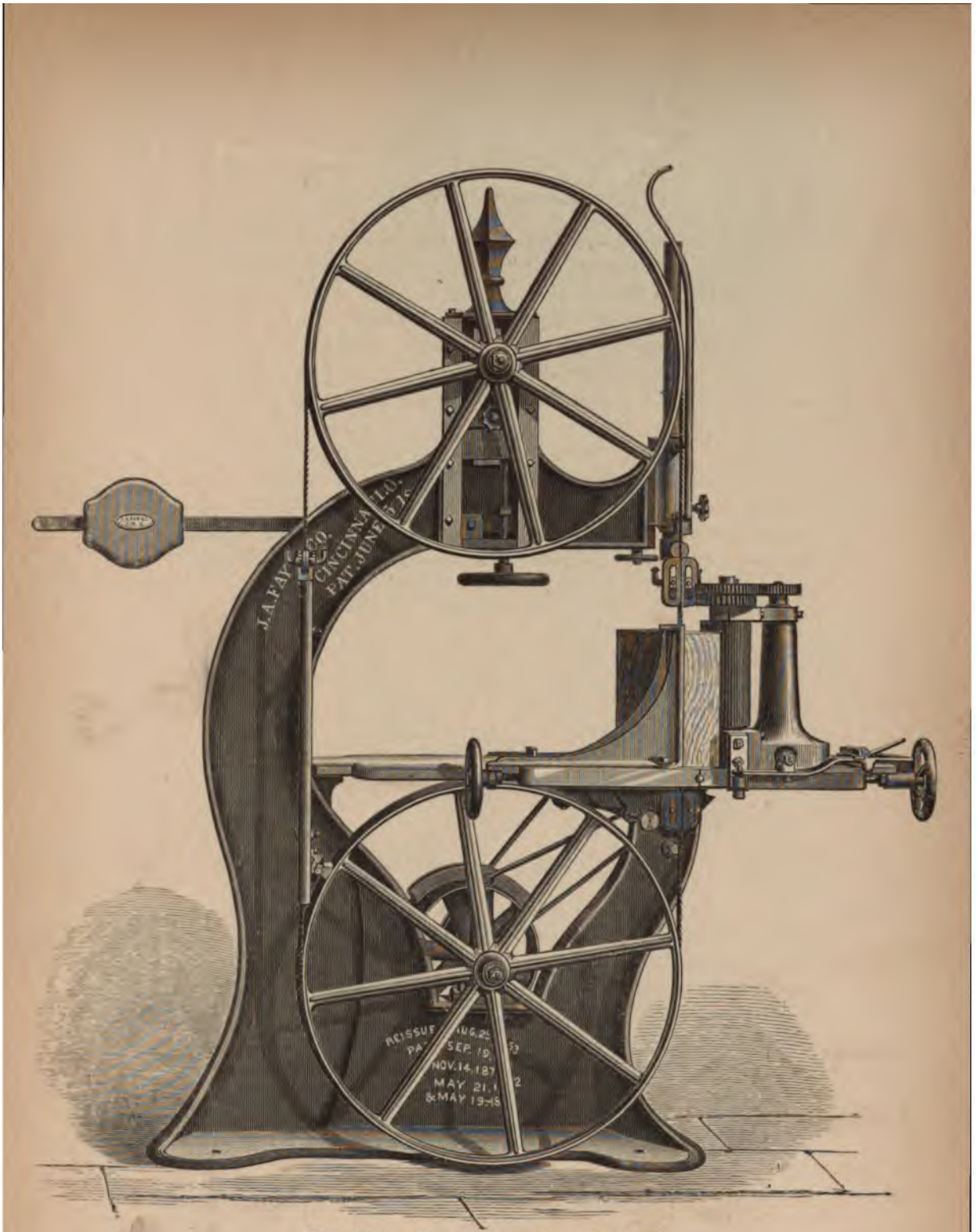


Fig. 132. Band Resawing Machine.

back edge of the band, no matter how carefully the back guide is made, even with steel balls rolling at the slightest touch; but by keep-

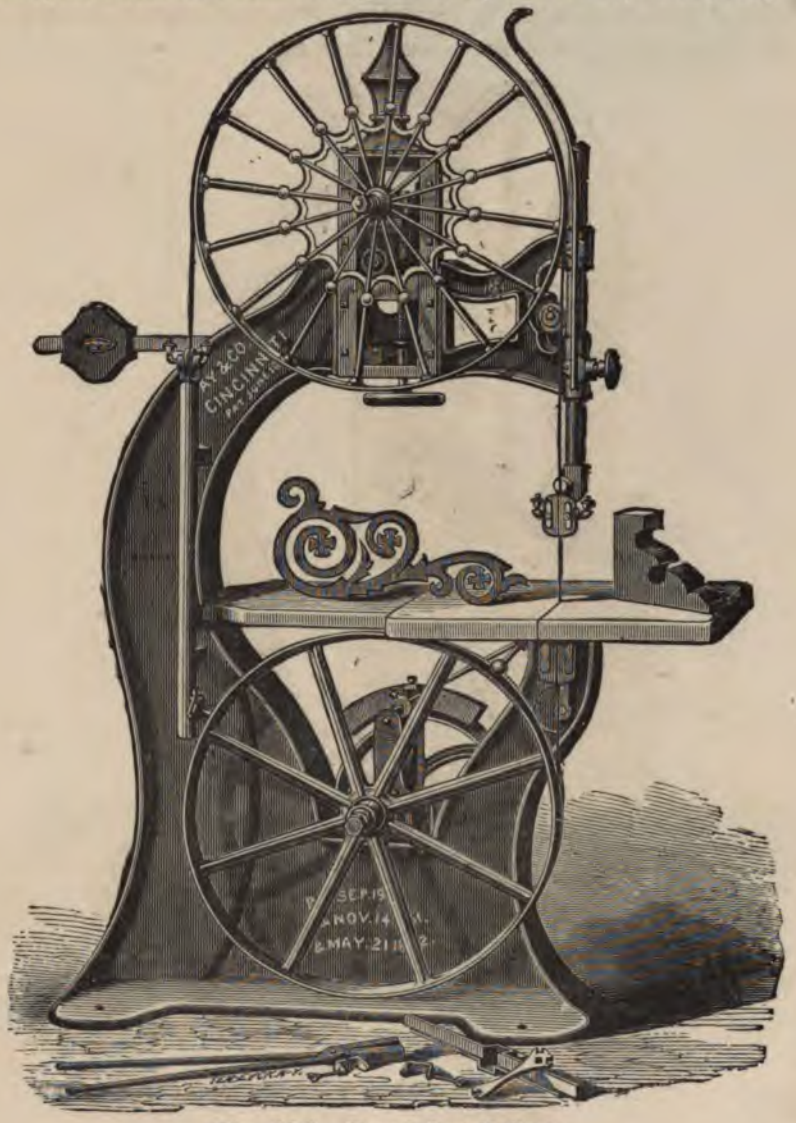


Fig. 131. Band Scroll Saw.

ing the proper pitch on a band-saw tooth it may be given a "lead" into the cut, thus lessening the friction on the stay-pin.

For soft wood the tooth space should be about one-half and their depth one-fifth the blade width. For hard wood, say space one-third and depth one-fifth the blade width. The gullet should be circular; the rake not enough to give a back thrust.

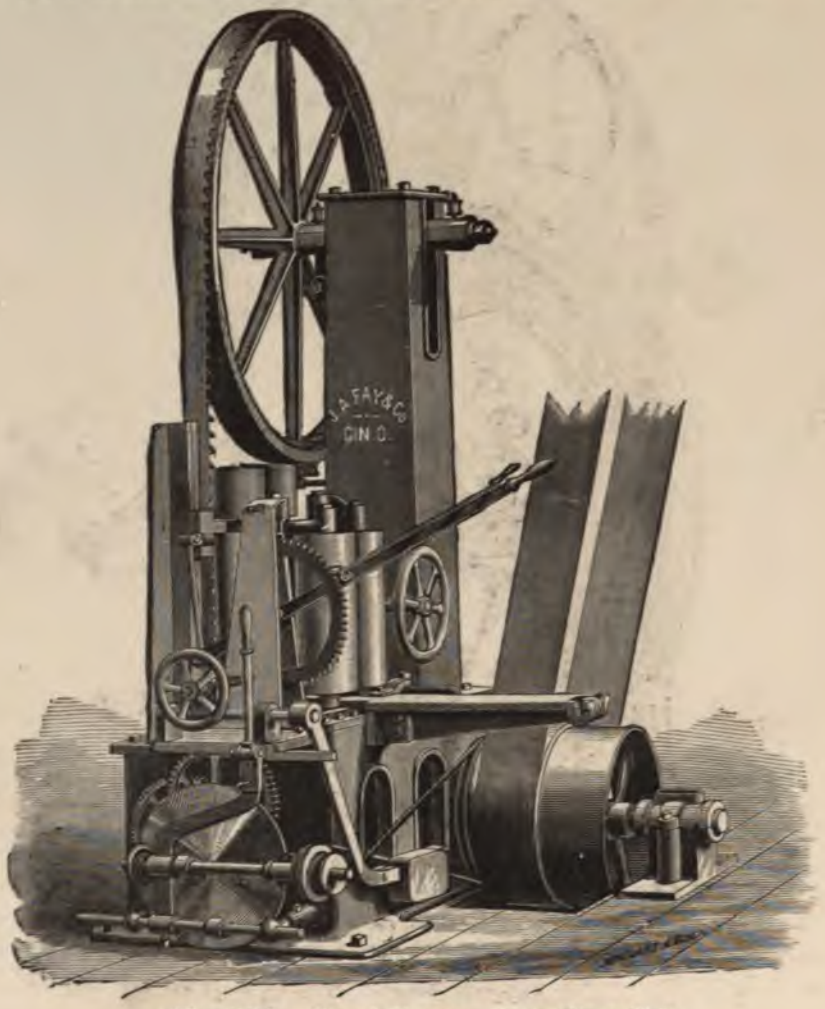


Fig. 133. Band Resaw—Operating Side.

As yet the band saw can cut but one kerf at a time, not being arranged in "gangs" as are the straight and the circular saws. We imagine that the principal difficulties to contend against in this direction would be connected with the tension and alignment.

Fig. 131 shows a band scroll sawing machine; Fig. 132, a light band re-saw, for working up to 14 inches, with saws up to two inches wide. (This takes a 5 inch belt on a 14 inch pulley, making 450 revolutions per minute.)

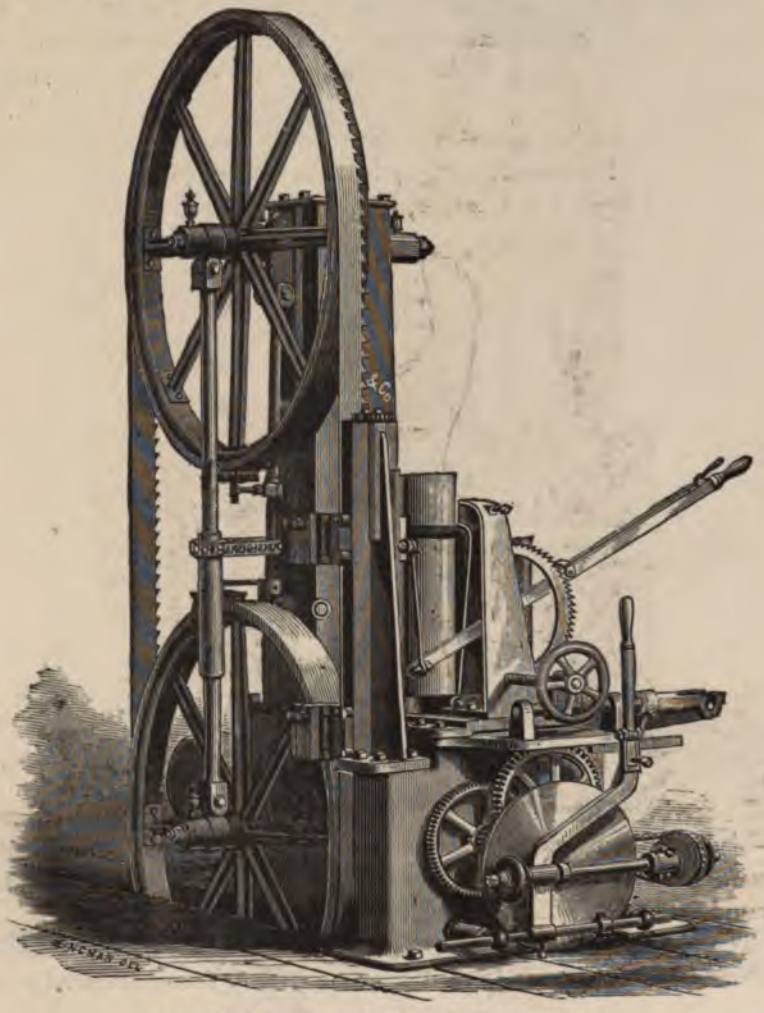


Fig. 134. Band Resaw—Rear Side.

Figs. 133 and 134 show respectively the operating and rear sides of a large band machine for resawing lumber into panel boards, or reducing deals to lumber. This takes up to 30 inches high and in the centre of

18 inches, the kerf being only $\frac{1}{16}$ inch. This machine will produce two $\frac{3}{8}$ inch panels planed on both sides from one inch lumber, instead of requiring $1\frac{1}{4}$ inch to produce the same stuff. The wheels are 60 inches diameter and take saws up to 4 inches wide, being placed close together to keep the blade as straight as possible. The pulleys of this machine are 30 inches diameter and 8 inch face, and should make 300 revolutions per minute, giving the blade over 4500 feet per minute lineal speed.

Band-saw blades from $\frac{1}{4}$ to $\frac{5}{8}$ inch are 21 gauge; $\frac{3}{4}$ to $1\frac{1}{8}$ inch, 20 gauge; $1\frac{1}{4}$ to 2 inches, 19 gauge; $2\frac{1}{4}$ to $2\frac{1}{2}$ inches, 18 gauge; $2\frac{3}{4}$ to $3\frac{1}{2}$ inches, 17 gauge; 4 to 6 inches, 16 gauge.

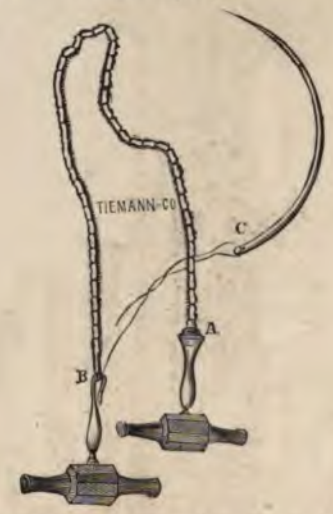


Fig. 140. Chain Saw—Concave Cutting.

To Perin, of Paris, the world is indebted for making the band saw —blades and machines—practical. His government very justly awarded him, for his services in this connection, the decoration of the Grand Cross of the Legion of Honor.

The nondescript CHAIN SAW merits passing mention. It comes in between the reciprocating rectilinear and the continuous curvilinear saws.

Fig. 140 is the ordinary surgeon's chain saw, introduced by means of the curved needle shown, and then fitted with the handles A and B, and pulled back and forth around the bone to be cut off. In this case it cuts with its concave side.

Fig. 141 shows a surgical chain saw, cutting with its convex edge. Messrs. George Tiemann & Co. have produced an entirely novel saw,

Fig. 141. Chain Saw—Convex Cutting.

the invention of Mr. F. A. Stohlmann. It is intended to replace the chain saw in common use, and is free from the tendency to bind,

kink, and break which characterizes the latter instrument. It consists, as will be seen in Fig. 142, of two handles connected by a wire of cast-steel, on which is strung a series of steel beads with sharp cutting edges. The instrument might indeed be called a file quite as appropriately as a saw, and its action on a bone is said to be more like that of the first-mentioned tool, in the absence of such rough edges as are made by the saw in common use. No needle is required to carry it through or around the bone, and its beads can be readily strung on a new wire in case of a break. Another advantage lies in the fact that the beads, by their free rotation, present fresh cutting edges; and still another is the considerable difference in price between this instrument and the ordinary chain saw.

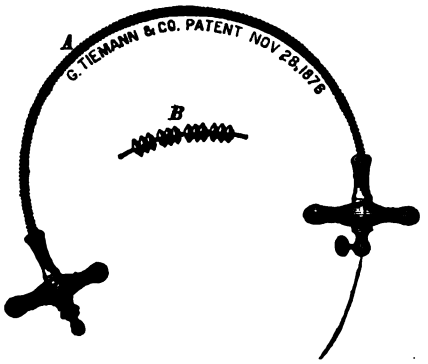


Fig. 142. Novel Chain Saw.

APPENDIX I.

SAW MAKING.

Inasmuch as this country possesses the largest saw manufactory in the world, and our needs as a new country, constructing so largely in wood, and exhausting forests for railroad ties and bridges, tend to develop the use of the saw—it may be presumed that our systems of saw manufacture and our skill in their employment are in no whit behind the age, and are worthy of public notice.

It is not many years since no American manufacturer dared to use American steel for saw making. The first successful attempt was made surreptitiously. Had it been publicly announced before succeeding, it would never have been the decided success it now is. Now we claim that the Old World may learn from us in saw making, and even buy from us the manufactured material.

A recent prolonged inspection of an immense saw works,* where the proprietors and foremen, all practical men, fearing neither publicity nor competition, exerted themselves to answer in detail our every question, enables us to present the following outlines of the process:

The steel, which is all "crucible," is made in the works, from Swedes iron, brands "hoop L. G." and "hoop F." The bars are cut small, and mixed with scrap steel from the manufacture of saws and files. Carbon is added in the proportion of 1 oz. to from 4 to 5¼ lbs. of iron (say 1½ to 1 per cent.) The thicker the saws desired to be made, the milder or less carbonized the steel. The material is melted in graphite pots holding from 65 to 85 lbs. each, and run in iron moulds into ingots varying in weight, dimensions and shape according to the style and size of saws required to be made. Thus, an ingot for 1½ dozen

* The Keystone Saw Works of Messrs. Henry Disston & Sons, Front and Laurel Sts., Philadelphia.

handsaws, 26 inches long, and tapering from 7½ to 3 inches, weighs 48 lbs., and is a flat block 6½×12×2 inches in size.*

For a 50-inch circular saw three pots full are required, and the ingot weighs 200 lbs. A 60-inch circular, rolled to No. 5 gauge and finished to No. 6 gauge, takes a 260-lb. ingot, hammered to the shape shown in Fig. 143, the pipe end or part which was uppermost in the mould being cut off, as shown by the V-shaped groove, because less solid than the rest.

For a "cross-cut" saw (familiarly written "×-cut") the ingot is cast of the form shown in Fig. 144, more convex on one edge than on the other. It rolls to the profile shown in Fig. 145, and is afterwards trimmed by shears to the shape shown in Fig. 146.

A 6-foot cross-cut of 14 plate requires an 11-lb. ingot. Peculiar tongs are used to grip the sheet, and great skill is required to prevent their slipping. While being rolled to the proper gauge the plates are slapped vigorously on the smooth and level iron floor, to slam off the scale and dirt, which would otherwise be rolled into them.

---

* "Some manufacturers—or at least one—has compiled from his practice a table of the weight of ingot required to roll out to a certain gauge and size of plate, so that, if an order is given to the rolling-mill to take an ingot of specified size and shape and roll it out to given dimensions, the result will be a certain gauge or thickness. By this means accuracy and simplicity are insured, since the skill of the workman in accurately measuring the gauge is not depended on. In point of fact, the workman need not be told anything about the gauge thickness. Fine measurements are not in his line, and, though he can measure the size of a sheet of steel, he is not at home measuring minutely to gauge.

As an example of the use of the table referred to, suppose it is required to make two dozen handsaws 56 inches long and of 19 gauge; a plate of 26x10½ will just make two such saws. Then the manufacturer calculates thus: 10½ (the width of plate) x 26 (the length of plate) = 273 inches; this will make two of the required saws. This, multiplied by 12, gives the area of plate required to make the two dozen saws. Then, turning to his table (which is a table of constant numbers) he finds against 19 gauge the constant number 72, and by dividing the area of plate required by this 72, he obtains the precise weight of ingot required to make the two dozen saws, and bring them out to correct size and gauge, allowing sufficient for trimming the edges of the plates. By this system (Joshua Oldham's) he is enabled to give to the rolling mill an order thus: "Roll me an ingot weighing 45½ pounds; cut it into 12 equal parts, and roll each piece to 26x10½ inches;" with the result that he will not be required to pay for rolling any more metal than that just requisite to make the two dozen saws, and the saws will be the proper gauge. (The reader will observe that the workman is not required to use the gauge at all.)

Plates so rolled will, for handsaws, be split diagonally lengthways, forming two saws from each sheet." [Joshua Rose, in *Cincinnati Artisan.*]

After rolling, the plates are cut to outline by powerful shears: then, if large, "gummed" or toothed by properly shaped dies in fly or cam presses.

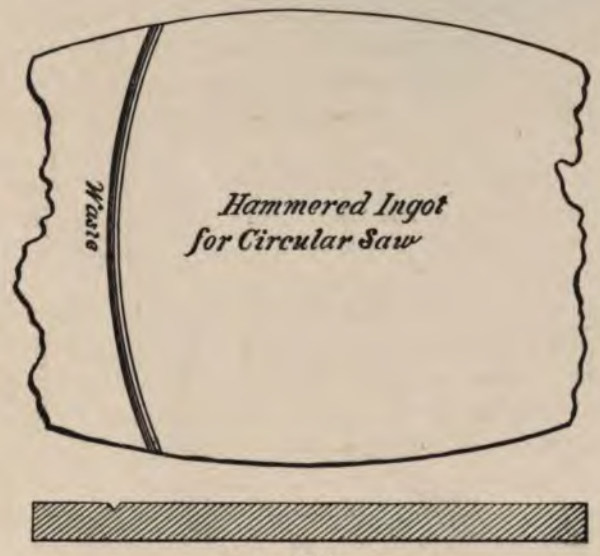


Fig. 143.

For small hand saws the teeth are nicked out by a rapidly-revolving cutter in an automatic machine, cutting out 500 teeth per minute.

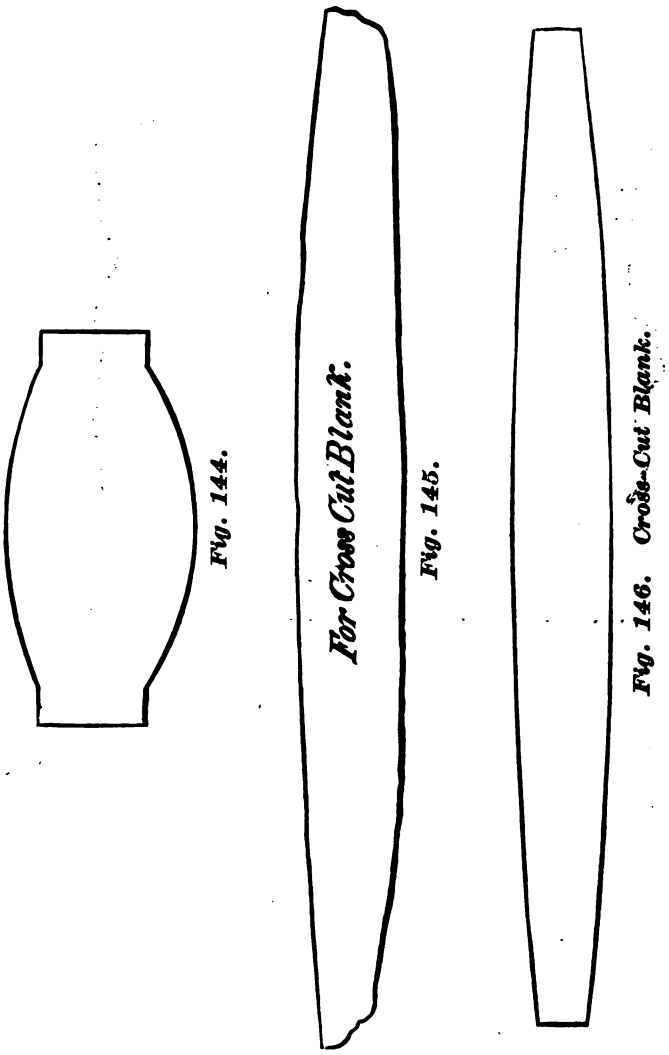
A Sheffield operator, using a fly press, tooths a handsaw with 115 teeth in less than two minutes, and his regular task is two dozen 24″ saws in eight hours. Circular saws have the eye driilled out before toothing.

The forms of teeth are legion. Various grades of work naturally require special forms and dispositions of teeth; added to which, customers have their own whims or ideas on the subject, and hold them very tenaciously.

As sawyers are quite apt to file circular saw teeth very wastefully, the establishment we visited has devised an original tooth shape, which may be adhered to until the plate is too much worn away for further use, and which is economical of saws, time and files. The principle is intended to make the tooth outline as nearly peripheral and as little radial as possible.

Referring to Fig. 148, the larger circle represents the saw outline, the inscribed circular arcs having their centres on the same circle, showing

the original tooth outline, which may be preserved throughout the life of the saw, at a minimum reduction of saw plate diameter. For woods



requiring shallower teeth the peripheral teeth lines are on larger circles, as shown in Fig. 148. The peripheral lines are left scribed on the plates, to keep the average sawyer from his natural tendency to dig in radially.

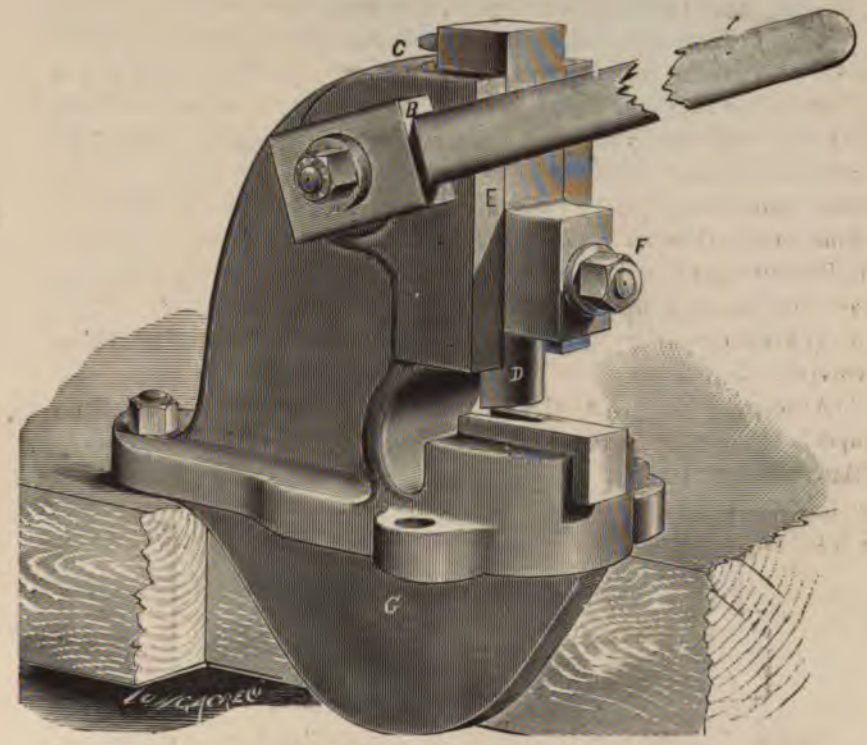


Fig. 147. Cam Press.

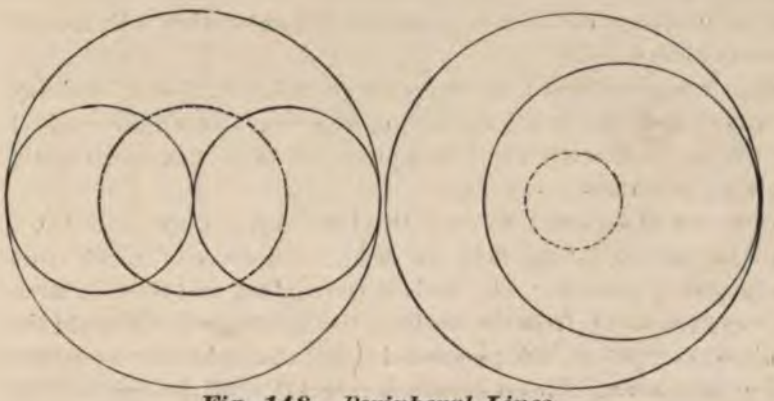


Fig. 148. Peripheral Lines.

After toothing comes hardening, the toothed plates being heated to a light cherry red, and then plunged in a bath composed of whale oil, tallow, rosin and beeswax. The plates, after hardening, should be as brittle as glass. They are covered with scale, grease and dirt, which is removed by scraping and scouring with sawdust. They come out buckled, and require to be flattened. This is done between heated dies brought together by hydraulic pressure. The dies are circular in form and horizontal in position, and about five to six feet in diameter.

They are enclosed in a furnace with an adjustable blast, and are revolved to keep the temperature even.

The proper color for handsaws is a blue, coresponding to spring temper.

After removing from the tempering dies, handsaws are piled up and held down by a weight of the shape shown in Fig. 149, to keep them flat and straight.

Fig. 149. Hand-Saw Weight.

Each hand-saw blade is tested by a straight-edge and by bending in a circle. If it does not perfectly recover its original position it is rejected and rehardened. The teeth of this same spring-tempered blade are then laid on a "stake" and struck smartly with a light hammer, to see if they will take a permanent set; unless they will, the saw is not up to standard.

After being "smithed" the blades are ground. Wood- and handsaws are sprung into the inside of the rim of a large rotating iron wheel (say ten feet in diameter), and thus presented to the face of a rapidly revolving grindstone.

Cross-cuts are ground between two huge stones (6 feet diameter, 8 inches face, and weighing 2638 lbs. each), the distance of which apart is regulated by a screw. The blade is passed back and forth between the stones, working from the back of the saw towards the teeth, the feed being reversed at each pass and the stones brought nearer together as they wear away. This operation is repeated until the saw is of the required gauge, the back being made two to four gauges thinner than

the edge by this process of inserting it first between the edges of the stone faces and passing the blade gradually inward toward the centre of the faces, so that all of it is *exposed*. The stones have a peripheral velocity of about 3000 feet per minute.

Large circulars are ground by passing them through a special machine having two large grindstones, the axles of which may be brought nearer together by a screw. The saw is on a temporary arm on a carriage having a traversing motion, so that all parts of its surfaces, from rim to centre, are exposed to the action of the stones. The stones run 2500 to 3000 feet per minute.

Circulars are ground even gauge throughout, or tapered at the rim, or thin at the edge, according to circumstances. Large saws are tapered at the rim, to make less kerf, take less power and lessen centrifugal force.

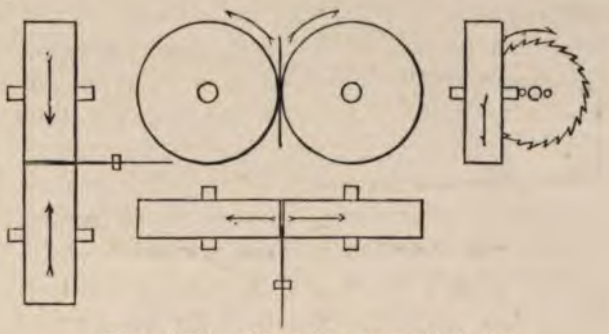


Fig. 150. Circular Saw Grinder.

Small saws and grooving saws are thin at the centre, to avoid the need of spreading or bending the teeth to give their clearance.

In the early days of saw manufacture all circulars were ground thinnest at the eye, because they were held on a face plate by screws between the teeth, and left free at the centre; the centre hence got the most grinding, as the screw heads must be cleared. Such saws, thinnest at the eye, would not have stood the high speeds and feed of the present day, then unknown—such, for instance as a 76″ circular, 6 and 7 gauge, 56 teeth, running 750 revolutions (15,000 feet) per minute.

Circular saws are polished and given the appearance of having been ground circularly, by revolving them on a face plate and pressing against them, successively, blocks of lead, cork and leather, supplied with emery and oil.

No matter how flat a saw may be pressed between the tempering dies, the majority of leading saw makers claim that the tension will be uneven in spots, and that hammering is necessary to equalize it.

A buckle or bend in a plate is known as a "tight" or a "loose" place. A circular which is flat and true and even in tension while at rest is, when running at a high speed, expanded more at the rim than near the eye, or is "centre bound," the rim waving and tending to cut out of line and run into or out of the log as influenced by a knot or any other inequality in the grain. This causes friction and heating and permanent "dishing." The rim expands proportionally more than the portions nearer the eye, because it runs faster, and perhaps because the tooth spaces weaken it.

It is the saw-straightener's duty to compensate in *advance* for the expansion due to centrifugal motion, by giving a rim tension which, while insufficient to actually dish the saw while at rest, will nevertheless be there when wanted, and will counteract the expansion of the rim at high speeds. If he give too much such tension, the plate, "rim-bound" when in motion, heats in the centre and dishes, as shown in Fig. 151.

When we consider that the compensating tension required to be thus given depends upon the diameter, thickness, temper and tension of the plate, and also upon the number, shape and depth of the teeth, the quality of the lumber to be cut, and the speed at which the disk is to rotate, we may well imagine that novices are not intrusted with this work, which requires in the highest degree experience, judgment and skill. The deliberate, steady, well chosen hammer blows are not to buckle or dent the blade, but simply to create or to remove local tension.

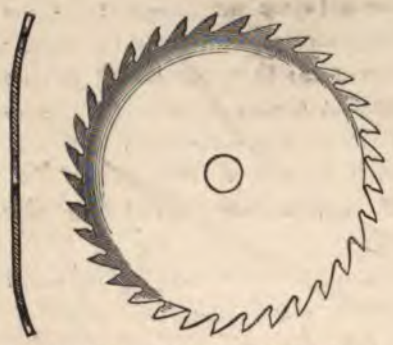


Fig. 151. Dishing Circular.

Fig. 152. Doghead.

The "doghead" hammer (Fig. 152) weighs about 3 lbs. Its length is about $5\frac{1}{2}''$ inches and its diameter $1\frac{5}{8}''$. The handle is $14''$ long and stands at an angle of 85° to the head. The face is evenly rounding. Fig. 153 is a blocking hammer, very slightly rounding at A. The block and anvil are shown herewith (Fig. 154).

The doghead is used mainly for stretching, or removing a tension. The handle being at the angle shown with the head, the blow is a dead one, free from spring or rebound. The head being heavy, and with rounding face, and the speed being slow, it leaves no "hammer *sinks*" or dents on the plate or blade.

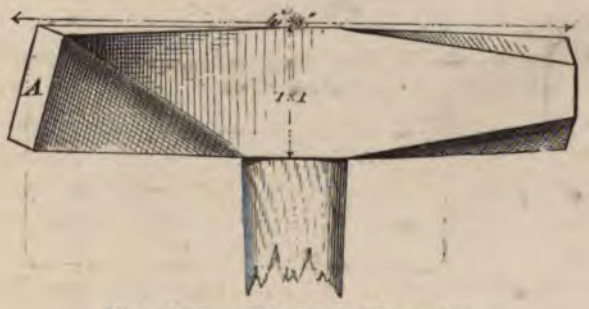


Fig. 153. Blocking Hammer.

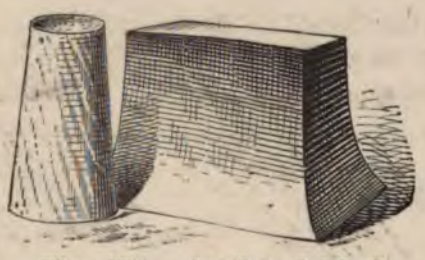


Fig. 154. Anvil and Block.

The parts of the plate under treatment must be perfectly flat on the anvil, else the blow would dent or distort the blade. Supposing the plate thus properly bedded on the anvil, a blow of the doghead may be given so as to stretch equally in all directions, as at *A*, Fig. 155, or by striking aslant, the effects are produced as shown at *B*, same figure. (Such slanting blows are always given *from* the operator, even if it be necessary to turn the blade end for end to do this).

The blocking hammer, Fig. 153, produces, by lateral motion, an effect to one side of the line of contact. Thus, in Fig. 156, using one face and a leftwise motion, the effects are distributed as shown at *B*, while with the other face and an outward motion, they are as shown at *C*. The curve of the face tends to lift or curl the plate up, the results being as shown at *A* and *B*, Fig. 157.

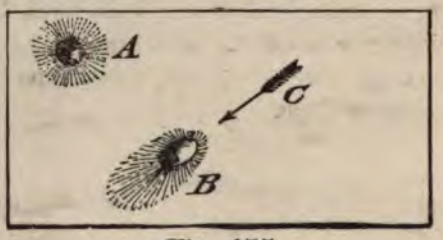


Fig. 155.

Fig. 156.

Coarser defects can be noticed by the expert as the plate lies on the block; lesser ones are found by "sighting" the plate, as in Fig. 158, the shadows denoting uneven places.

Fig. 157.

Reversing the plate, as in Fig. 159, and bending it back and forth, expanded portions move more easily than the average; tight places are stiffer and must be stretched—this equalizing the tension also. The

straight edge (Fig. 160) is frequently applied during the hammering process.

Fig. 158.

Fig. 159.

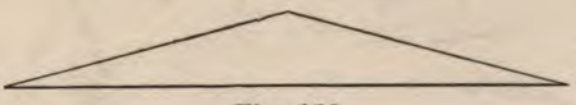


Fig. 160.

The plate should be well bedded to the anvil while receiving the blows, otherwise the hammer will "drum" and the plate will become convex on the hammered side by reason of stretching its skin.

Fig. 161 denotes a blade loose in the middle where the oval shadow is given. To remedy this, blows with the doghead must be shown, as

shown by the marks *A* and *B*, thus, stretching the parts struck and allowing the loose place to flatten, while slightly lengthening the blade.

If, however, the blade were "tight" in the center it would be struck as at *A*, Fig. 162, to stretch the tight place. If it were atwist, as shown in Fig. 163, the blocking hammer would be used, as shown by the heavy line-marks, the plate being placed with drooping side down, and the hammer curling or lifting this.

To remedy a kink or wave (Fig. 164) the plate is placed with the

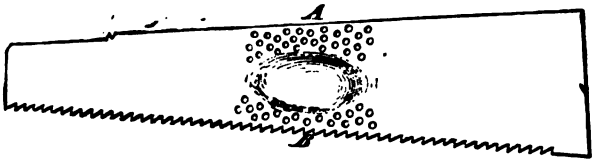


Fig. 161. Loose Centre.

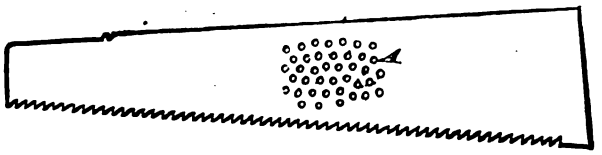


Fig. 162. Tight Centre.

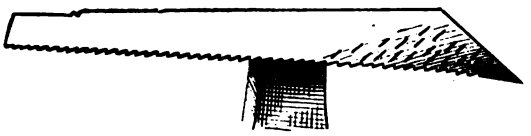


Fig. 163. Atwist.

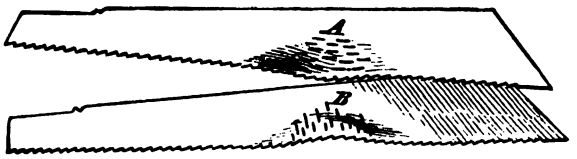


Fig. 164. Kink.

hollow face of the kink downwards and struck as at *A*, lifting the part kinked. Turning the plate over, the blows *B* are then given, removing the kink.

Fig. 165 shows a dished circular plate, which must be undished by putting the concave upwards and striking as shown, thus tending to stretch the top and straighten the plate.

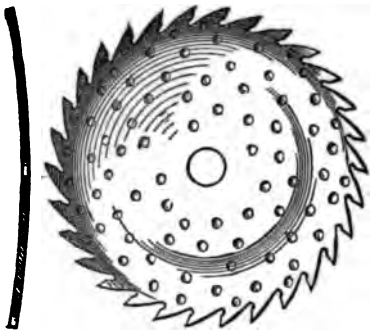


Fig. 165. Dished Circular Plate.

APPENDIX II.

Care and Use of Circular Saws.

The shape of teeth is most important, as regards not only their cutting, but the economy of the plate. The dotted lines of Fig. 166 show circular saw teeth as they are when they leave the factory; they sometimes get down to the shape shown by *B*, *C*, *D*—without sawdust room. Such filing also uses up files and saws, while cracks are liable to start in the sharp angles or the teeth break off as at *A*.

Fig. 168 shows, in full size, what Disston calls the "Jones tooth," filed from the top instead of from below. Dotted line 1 shows the circumference on leaving the factory; 2 shows where the periphery should have been brought by properly filing; line 3 shows where the periphery comes to by bad filing. And yet from *A* to *B* is as far as from *A* to *C!* This tooth is also highest at the back, scraping instead of cutting. and it has no dust chamber.

If the saw be dull, either at or *under* the points, as seen in Fig. 169, it will not do good work.

Looking at points *A* and *B* of Fig. 169, (showing a cracked saw) it is easily seen that it is broken by over-work while dull. A tooth of a 24-inch circular saw strikes the wood at the rate of 9000 feet per minute, 2000 times per second, 1,200,000 times per day, and if not sharp the saw must eventually, even if once strong, get tender and break, as seen at *D*.

If the tooth takes one-eighth inch hold of the wood at each revolution it gets dull one-eighth inch below the point, and proportionally for other feeds.

If the saw were a razor and the man who works it were obliged to shave with it, then the saw would be kept sharp. It is quite as essential that a saw be sharp as as a razor,or plane, or any other cutting instrument; and when proud, or full and sharp, it does not require one-half the set or power on the same feed.

While a tolerably good workman may run a mill, yet a good sawyer's lumber always brings higher price than that of a less skilled man.

A saw often improves in temper by use, as the extreme points of the teeth are often too soft at first.

A saw improperly hung, unevenly set, filed untrue; teeth lacking pitch, or having too much; teeth with back higher than point, with scant dust room, or the plate unevenly balanced—all cause trouble.

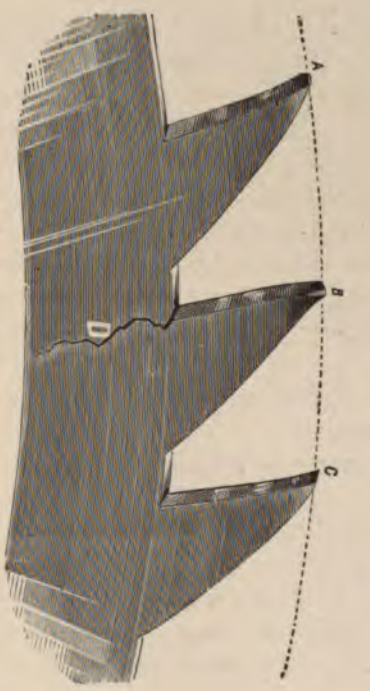


Fig. 169. Cracked Saw.

Fig. 166.

A saw will not balance rightly unless absolutely round, having teeth of equal size and shape and gullets of equal depths.

The guide or gauge of a bench saw should never pass the centre of the saw.

A saw plate may be in perfect condition and yet not run true, on account of lack of truth in the collar.

It is best to take a full deep cut, rather than a light scraping one. With a buzz saw, having $\frac{1}{32}$ inch feed, it takes thirty-two teeth to cut an inch of lumber; with $\frac{1}{8}$ inch feed, only eight, and you break the fibre only eight times instead of thirty-two. Of course the tooth gets dull further under with the higher feed, but requires very little more sharpening.

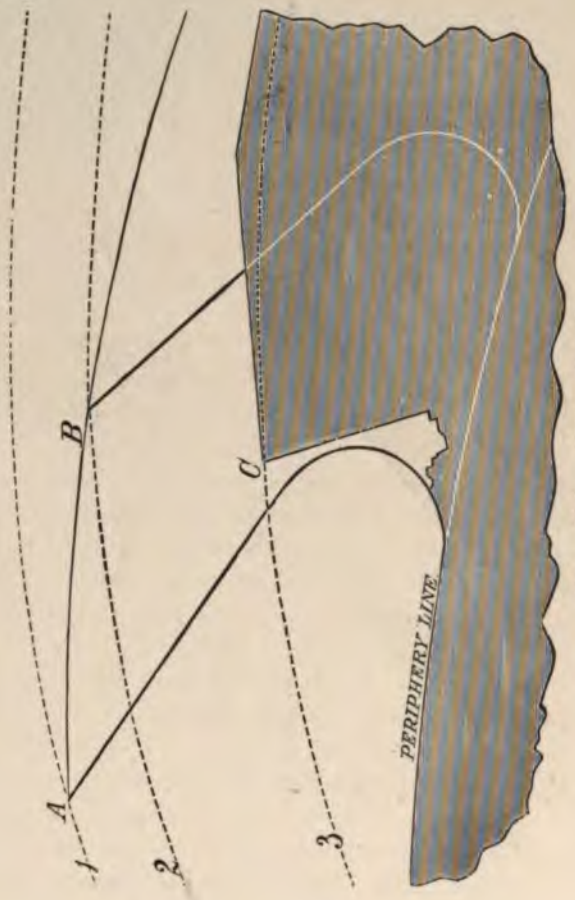


Fig. 168. Jones Tooth.

APPENDIX III.

SAW FILING.

Hardly any two sawyers agree as to the exact "best mode" of filing. So many published and unpublished opinions directly contradict one another that we feel justified in adhering to Holzappfel's directions, modified somewhat by the changes in files and in saw teeth which have come about since then.

We will consider straight blades first. They should be held teeth upwards, in a "clamp." Strips of wood or sheet lead between the clamp jaws absorb the vibrations and lessen the horrible screeching so annoying to nerves.

If a saw be allowed to shake and jar while being filed, it is almost sure to break the teeth out of the edge of a good sharp file; and the better and sharper the file, the more liable it will be to break by such filing. By holding the file firm and down close to the jaws of the clamps the files will last much longer, and a keener edge may be got on the saw.

The best cut for saw files, except for very small teeth, is "float" or "single," made by a single row of chisel cuts.

The five diagrams herewith given show, each, three views of the teeth. For metal-saws the file is held 90° in both vertical and horizontal angles; for hard woods, 90° to 80° horizontally; for soft woods, 70° to 60° and less, the vertical angle being half the horizontal, but less important. Filing teeth bent *towards* the operator causes great chattering and screeching and strips the file teeth. First, "top" or "*joint*" teeth by passing the file lengthwise over them, to equalize their length, bearing harder on the ends (where there is least wear.) File the faces or fronts before the tops. When the teeth are to be square, file in regular succession 1, 2, 3, 4. When the file is inclined so as to give "fleam," file 1, 3, 5, 9 to right, 2, 4, 6, 8 to left.

Fig. 169 shows teeth for metal frame saws (blacksmiths'). Small metal saws, made of watchsprings, are filed with a guide fitting in one notch and serving as a bearing for the side of the file in making the next tooth back.

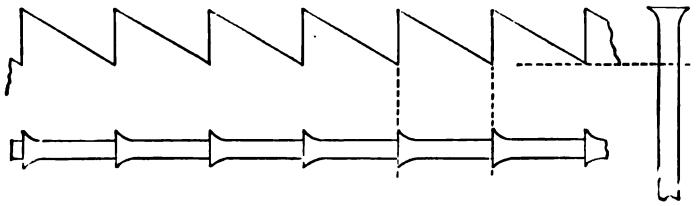


Fig. 169.

Fig. 170 shows the "peg" tooth with plenty of fleam. M teeth and mill saw teeth are sharpened about the same as the peg.

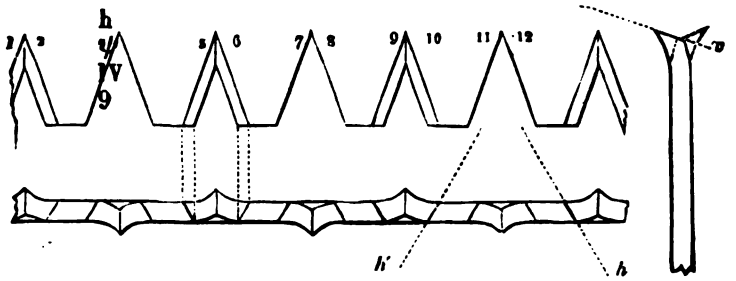


Fig. 170.

File sides 1, 5, 9 (the left of alternate teeth), at horizontal angle *h*. Then opposite sides of same teeth, 2, 6, 10, with reverse angle *h'*. Then the other teeth, from the other side of the blade, that is, 12, 8, 4; then 11, 7, 3.

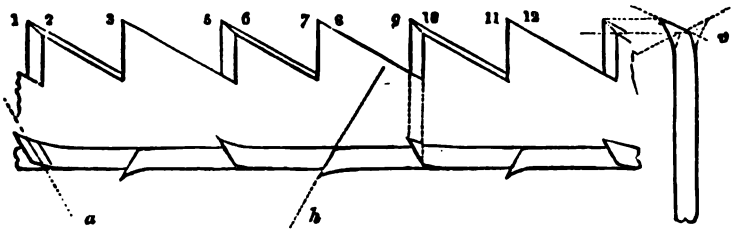


Fig. 171.

Fig. 171 shows teeth with 60° angles, as those of the hand-saw. The file generally cuts a front and a back at once. After topping, file

1, 5, 9 (alternate teeth) back to the centre of each face produced by topping. Then take sides 2 and 3, 6 and 7, 10 and 11 of the nooks, and file them forward to meet the line *a*. This finishes faces 3, 7 and 11. The saw is then changed end for end, and tops 4, 8 and 12 finished. Thus the first course files a face only of odd teeth; the second, the *backs* of odd teeth and *faces* of even; the third, the tops of even teeth.

Fig. 172 shows a pruning saw for green wood, ground very much thinner at the back and not set. Excessive bevel is given, and it cuts clean and sweet.

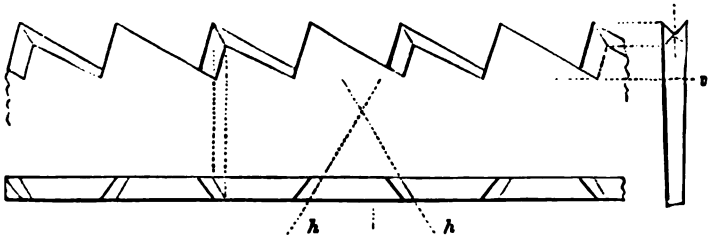


Fig. 172.

Fig. 173 is done with a pit-saw file smaller than the gullet. First, make gullets 3, 7, 11 very obliquely in the vertical plane; first filing the face of one tooth and then the back of the other. Then file tops of teeth 4, 8, 12 with flat side of file, at angle from 5° to 40° with the edge, and 80° to 60° with the side of the blade (the 5° to 80° being for the hardest and 40° and 60° for the softest woods).

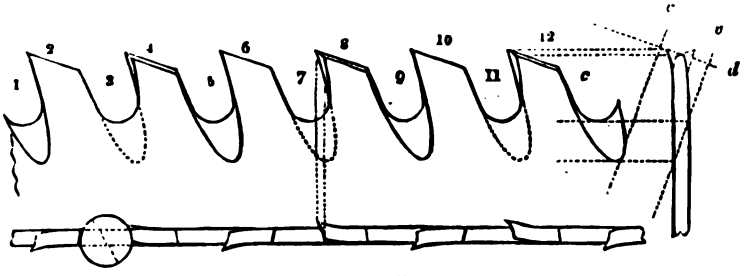


Fig. 173.

File the front of all teeth set from you, and the back of those set towards you. The most frequent custom seems to be to file from front to handle.

From 6 to 8 inches at the point of the hand rip-saw may be filed

at a less angle than the rest; that is, at the "cross-cut" pitch. This enables the sawyer to rip through knots without changing saws.

Some advise making a swell in the center (say ¼ inch in a 26-inch saw), to counteract the rocking tendency of the sawyer, whose hand tends to go down on the forward stroke.

Some experienced men advocate going over the saw in three light filings to produce a keen regular result.

The last teeth of cross-cuts may be rounded at the points to prevent tearing on entering and leaving the cut.

Fig. 174 shows a hardened steel gauge for regulating clearer teeth; the file should dress off projecting points to a level with the gauge.

Fig. 174. Clearer Gauge.

A cross-cut hand saw should cut a little more on the down than on the up stroke, as the arm is there strongest; hence the teeth should pitch a little forwards.

The "wire edge" should be taken off with a whetstone, after filing.

In sharpening an under-cut or a parallel tooth there is danger lest the original shapes get perverted, as in *C* and *D*, Figs. 175 and 176.

Fig. 175.

Fig. 176.

By the use of a special section, as the "Lumberman's" cross-cut file, an M tooth with slightly inclined sides is easily kept in condition. "As you pay for the edge of a file as well as the flat, why not use it?"

Figs. 179, 180 and 181 show the mode of applying a special section file to the "Great American" cross cut.

Fig. 179 shows the manner of filing the long edge of the end tooth; Fig 180, the short or inside edge of the end tooth; Fig. 181, the gullet.

Fig. 177. Using "Lumberman" File.

The adjustable clamp shown in Fig. 182 enables a saw to be filed at any angle, or square, as desired.

Band saw files have their edges rounded to make the notches less liable to start cracks.

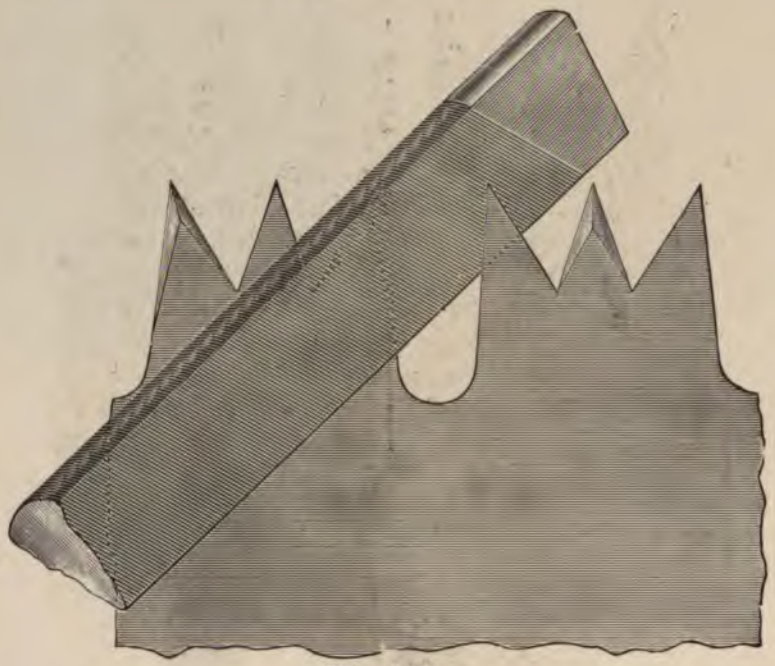


Fig. 179.

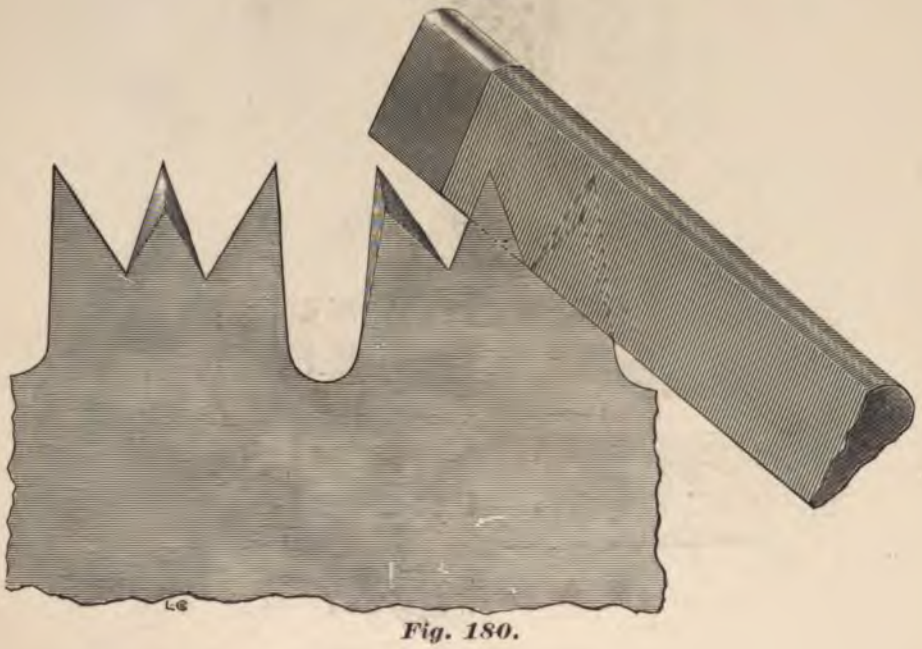


Fig. 180.

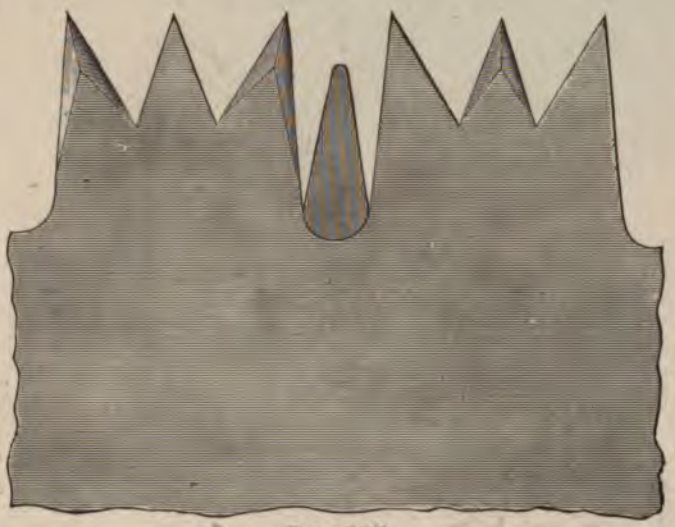


Fig. 181.

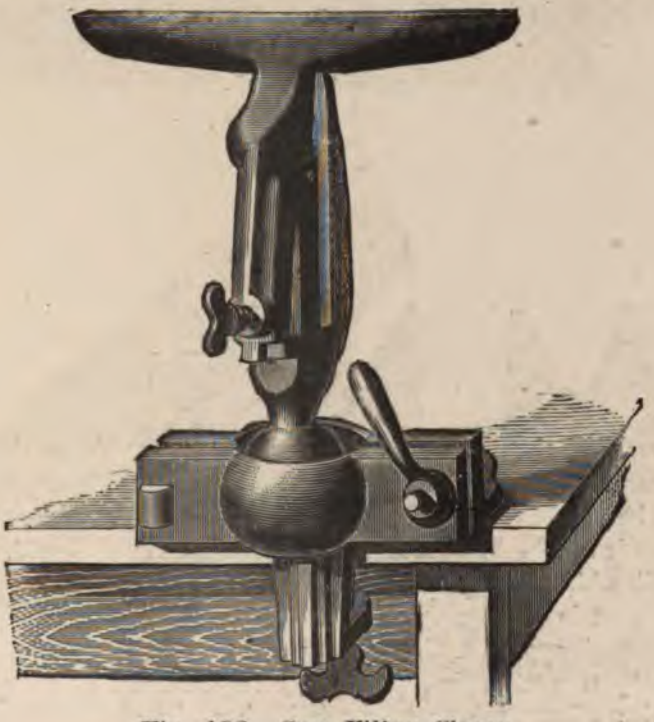


Fig. 182. Saw Filing Clamp.

We remember seeing at the Centennial Exposition, Philadelphia, a band sawfiling machine employing a spiral or screw file with a pitch equal to the tooth space, and hence self feeding. Rotation of the file sharpened the band evenly and fed it along automatically. The file, however, has the disadvantage of being difficult to forge, temper and cut, and of being uiilizable on one corner only.

Shingle saws should be filed square across the teeth, and given just enough set to clear the blade.

In filing circular saws, many men are in too great a hurry to get the teeth sharp, and file from the top rather than from the front or bottom.

In Fig. 183, dotted line *B* shows where the point first wears; *CCC*, how it should be filed back; but too often, on account of the long surface, and the sharp corner at *I*, the filing is done on the top. Filing back on line *CCC* the diameter is diminished only to *F*, while from the top you work it down to *D*.

In Fig. 184 the same tooth is shown, gummed by a machine and leaving but little under filing.

Fig. 183.

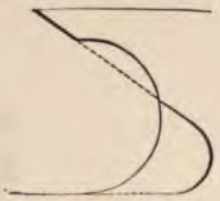


Fig. 184.

Never file a circular saw to a "proud edge," but file on the under side near to an edge, striking lightly. Keep the teeth very hooking with a bevel of one-sixteenth, swaged, not filed, on the under side.

Circular saw teeth, "out of round" should be marked with a piece of chalk while the saw revolves slowly.

To ascertain whether a circular saw tooth is exactly to shape, a sheet steel gauge is applied as shown in Fig. 185.

Exactly even setting is impossible; some teeth will overhang more more than others; this causes rough lumber. The adjustable *side file*

gauge (Fig. 186) enables absolute uniformity to be given, after setting, and by its use a saw may be enabled approximately to "plane lumber."

The "side file" is to regulate the teeth after setting, and prevent unduly projecting teeth from making rough lumber. The set screws adjust the file to any set desired; the jaw nuts hold them tight.

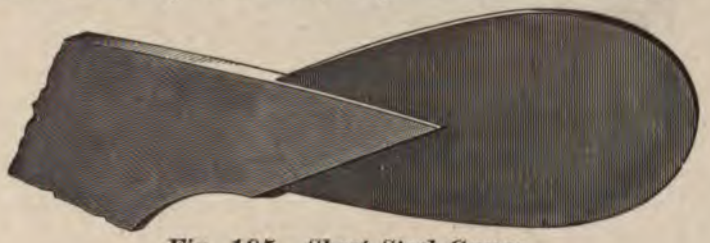


Fig. 185. Sheet Steel Gauge.

Fig. 186. Side File.

Fig. 187 shows an adjustable filing machine for filing circular or straight saws. It will file a tooth square top and bottom, or bevel point and square back, or square point and bevel back, filing from right to left or left to right.

For ordinary hand saws a triangular file is employed, the contour being taper, as shown in Fig. 188, and the lengths 3, 3½, 4, 5, 6,

8 and 10 inches. An improvement is the "slim hand saw taper," Fig. 189, made from the same sized stock; the lengths being 4, 5, 6, 7, 8, 10 and 12, inches, giving greater sweep or stroke.

The ordinary three-square file (Fig. 190) is not intended for saw filing and utterly unfit therefor. They are generally as thin as possible in the edges and corners, drawn and cut to a small point, and double cut to the point. All saw files, whether double cut or single cut, are cut on the edges or corners as well as on the flats or sides. Fig. 190 shows a three-square file for machinery; Fig. 188, a saw file.

A very valuable improvement is the "double ender" file, with accompanying handle, Figs. 191, 192 and 193. The file may be one end double cut and the other single, or one end coarse and the other fine, and is perfectly adapted to the split handles made to accompany it.

Fig. 187. Saw Filing Machine.

The "blunt end" file (Fig. 194) is by many preferred to those having sharp points. A step still further in this direction is the knob end (Fig. 195), giving better hold of the file by the finger and thumb of the left hand, and thereby enabling the filer to more easily control the use of the tool.

It is even less liable than the plain blunt end to cause soreness to cause soreness to the ends of the finger and thumb by much filing.

To use the reversible taper file in a regular handle, bore in the handle a hole about the size of the point of the file, and then counter bore, about halfway down, nearly the size of the full part of the file.

One manufacturer makes the reversible taper with blunt points (Fig. 196).

We have never yet been able to see why any taper should be given

Fig. 188. Regular Taper Saw File.

Fig. 189. Slim Taper Saw File.

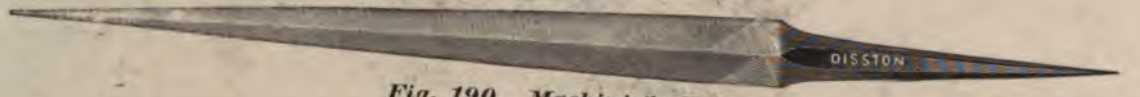


Fig. 190. Machinist's File.

Figs. 191, 192, 193. Double-Ender Taper Saw File and Handle.

Fig. 194. Blunt End Taper Saw File.

Fig. 195. Knob End Taper Saw File.

Fig. 196. Blunt End Reversible Taper Saw File.

to a saw file. If any part of a taper file be the right section for the notches in the saw, the other parts must be the wrong size. Furthermore, either the wear must overlap from both sides, or an unworn stripe be left along the center line. A three-cornered saw file should be in width a trifle more than twice the depth of teeth to be filed. If wider, the extra width is wasted, as it never gets any work.

Fig. 197 shows Roth's saw file guide applied to a small circular saw.

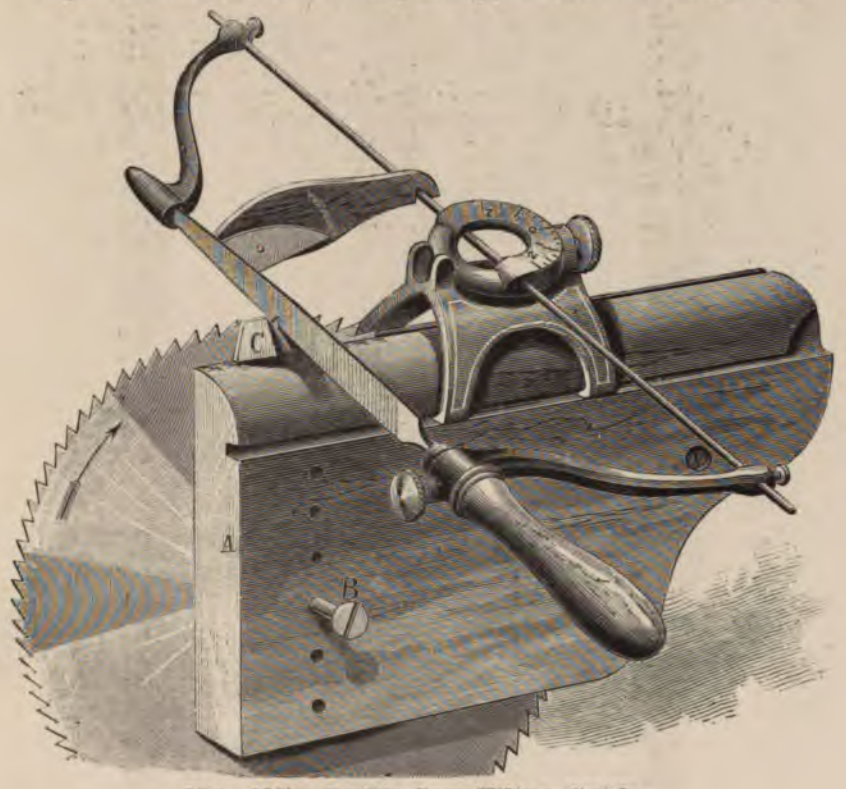


Fig. 197. Roth's Saw Filing Guide.

There is a circle, divided and numbered from its centre each way, giving bevels for each side of the saw, or square across—shown in the cut. The file is fitted into the handle, and is held by a set screw, and may be readily turned so as to use any corner of the file. The indicator shows the pitch at which the file is set. The rod passes through holes in the graduated ring and guides the file. The frame upon which the ring is held slides in grooves cut on each side of the clamp

in which the saw is held. A table connected with the guide is arranged and figured, so as to give the required bevel and pitch for the kind of saw to be filed; and it is only necessary to set the ring for the bevel and the indicator for the pitch, and the machine is ready for use. As the filing is proceeded with from tooth to tooth the frame follows, giving the same bevel, pitch and size to each tooth, and on one size of the saw the same as on the other, thus leaving the saw, when finished filing, with the teeth all of the same size, pitch and bevel; and each tooth will do its share of cutting equally throughout the entire length of the saw, cut straight, smoothly, easily and rapidly. The operation of filing with a machine does not tire the eye; may be readily filed without taking them from the arbor or shaft, and each size of saw will have its teeth all of an equal pitch and bevel, so as to do the greatest amount of work in the best manner, and with the least expenditure of power.

APPENDIX IV.

SPRING SETTING.

There is perhaps little need for a lengthy appendix on setting. It must be premised that, by the term setting, springing or bending the teeth is understood, as distinguished from "spread set" or swaging.

The operation of setting any kind of saw is an important one, as upon the judgment and accuracy displayed depend very largely the performance of the tool. The primary object, as before mentioned, is to give more clearance than can be given by grinding a straight blade thinner at the back than at the cutting edge, or by making a circular thinnest at the eye, which last, although practised in the early days of circular saw manufacture, when the disk was held on a face plate by screws at the edge, is disadvantageous for large saws and high speeds, as leaving the rim unduly heavy, and is used only for grooving saws and small disks. A 72-inch circular, running two miles a minute at the rim, must naturally be as light as possible towards the circumference.

The principal advantage in giving clearance and thus lessening friction and heating, diminishing the power required to drive the saw and keeping the blade straight, is partly offset by suppressing one cutting edge of each tooth; and yet that cutting edge acts (if the set be good) at a better angle than if no set of any kind were given. Spring set enables the sawyer to adjust the saw to varying kinds of material, or to the operation to be performed, as ripping or crossing. In common with swaging, it aids in affording clearance to the sawdust. There is the disadvantage that set springs the tooth into the work when sharp, and away from it when dull, and that the effort of overcoming this tendency to dig in, increases the power required to run the saw. For cutting hard and knotty wood, and for some other materials, much set

is impracticable. For ice, all must be given that is safe, that is, just enough not to endanger the strength of the tooth.

Figs. 198 and 199 give respectively the ancient and the modern mode of giving "set."

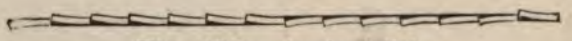


Fig. 198. Ancient Set.

Fig. 199. Modern Set.

The modern method of setting alternate teeth to right and left diminishes clattering and makes a clean smoother cut. The ancient way of setting half a dozen adjacent points each way, was apt to produce a ridgy cut, like a washboard, thus;

Whatever set be given, it must be regular, and must not extend beyond the base of the tooth; that is, the set must be given the tooth, and not the plate. In manufacturing hand-saws, the temper of each is tried by setting a few teeth on a stake, with quick hammer blows. One authority states that the plate itself would not stand this test. But Disstons claim that the back of a good hand-saw may be given a set all along; and it is certain that by constant filing, what was once the plate below the tooth line becomes in time part of the teeth, and must be set. But so long as this metal is not in the tooth proper it should be left unstrained by local tensions.

The two principal modes of setting are by sharp quick hammer blows and by bending. The former mode has the disadvantage of being less regular, except perhaps in the case of those machines used to set hand-saw blades, where the force of the blow is determined and kept uniform by a spring or weight.

The simplest saw-set we know of is a notch in the side of a file tip—having the advantage of being at hand when wanted and not necessitating a special tool. But with such a bending device the amount of bend must be regulated by the feeling of the operator; and perhaps it is best to have a separate set, with a stop, enabling one to vary the amount of bend given to the teeth, and to keep it uniform throughout. The cuts show common forms of saw sets. They have the advantage of neither oversetting nor undersetting.

If any one tooth projects beyond the others it will get undue work, and either dig in and break, or retard the cutting, or limit the capacity of the saw by "masking" those which follow it and are by it prevented from touching the wood.

Fig. 200. Saw Set.

Fig. 201. Saw Set.

APPENDIX V.

SWAGING.

Swaging, swedging, or jumping, is the upsetting, widening or spreading of the teeth to give clearance, etc. It is best effected by a steel die having a ∧ notch in it, to conform to which the tooth is smartly hammered. It hardens and condenses the metal. Extreme spread, as is our Southern usage, necessitates the sacrifice of temper in the tooth. In one form of die the sharpness of angle is obtained by sawing a kerf in the angle of the ∧ and driving the parts together by a ring (see Fig. 202). The lower opening in this swage is rounding and spreads and shapes the teeth as seen at *H*. The upper one is for squaring up to the style *G*. The kerf in the notch enables a fine sharp angle to be made and maintained and permits the hardening composition to enter freely that portion of the die which does the most work.

In another there is an adjustable wall to the notch, which can be set up by a screw to any desired acuteness of angle (see Fig. 203.

Sometimes one or more teeth will strike gravel or some other hard substance, and take off the point. To obviate cutting down all the rest of the teeth, the short tooth may be lengthened, as shown in Fig. 204 (an inserted tooth). Mark the short tooth with a file on the under side, so that in filing it will be recognized. Raise the swage in the act of upsetting, and the point will be raised up as shown in Fig. 205. A *light hammer* should be used in swaging.

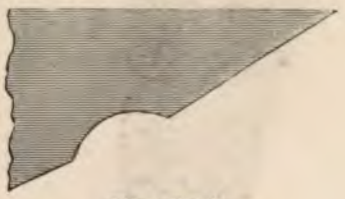


Fig. 204.

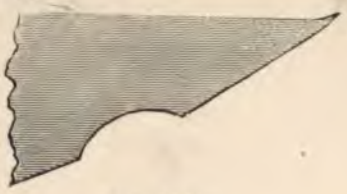


Fig. 205.

Fig. 202. Swaging Circular Saw Teeth.

Fig. 203. Emerson, Smith & Co's Swage.

APPENDIX VI.

GUMMING AND GULLETING.

Gumming and gulleting may be done with (1) a file, (2) a press or punch, (3) a milling cutter, (4) an emery or corundum wheel.

When the hardness of the material to be removed be considered, it is easy to see that some of these modes have advantages over the others in point of time, labor, and material consumed, and evenness of results obtained.

The file is slow acting and not readily renewed when dull. Its use answers for small and hurried jobs, and those done without removing the saw. Its use is shown in Fig. 206.

The press or punch is used in the process of manufacture, and necessitates the removal of the plate.

Fig. 207 shows a hand press for saws not thicker than 12 gauge. The lever *A* is detachable, fitting on socket *B*, cast on the end of a rack pinion gearing in the rack *C* in the back of the slide carrying the punch *D*.

The punch is held by the clamp *E* and next *F*, the top of the punch bearing against the end of the slot in the slide, and removed for grinding by loosening the nut *G*. When the punch gets short and the lever too low, the pinion-wheel should be withdrawn and changed one or more teeth.

The milling cutter is one of the most rapid and even working tools used, and without it the circular saw would often be of little use. It may be driven readily by hand, having adjustment for depth of cut and automatic feed given at each revolution. One is shown in Fig. 209. The chambers it makes must in every case have a semicircular bottom —a very advantageous form for the throat. To use it a circular saw need not be removed from the arbor. The economy of saw plates

resulting from its use can hardly be estimated, while the speed and regularity of its action leave nothing to be desired.

Fig. 210 shows a cutter grinder for holding the cutter of a chambering machine in position during sharpening.

Fig. 206. Using "Lumberman" File.

Fig. 211 shows a most important and successful invention—the "spiral line" mode of gulleting. By making the back line of each tooth the continuation of the spiral lines Z, the sharpening is mainly done by gulleting the throat with the rotary gummer (Fig. 209). The

cutter, in traversing the spiral line, reduces the front or throat of tooth *D* while prolonging the point line of *C*. The saw *B* is the saw as worn down. A reduction on radius from *G* to *F*, say 6 inches, corresponds to a distance *G* to *Y*, on the spiral line, 24 inches. The gullet is semicircular, whence an advantage, an inch and a half tooth keeping as clear as a two inch ordinary tooth. Wearing a 54 inch plate down to a 42 inch would give only six sets of two inch teeth, but eight sets

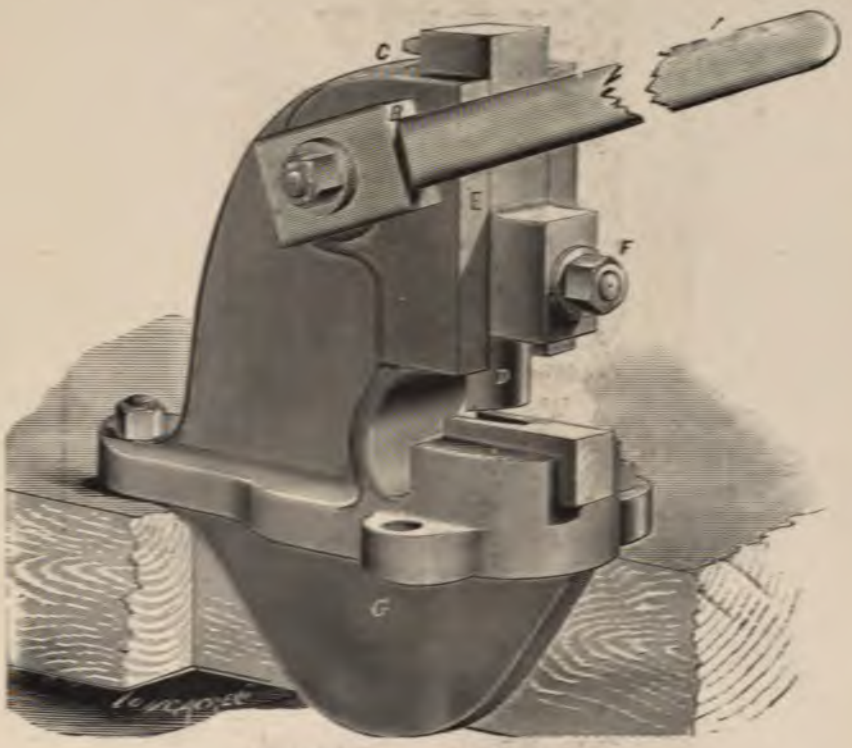


Fig. 207. Gumming Press.

of one and a half inch. This method preserves the true round of the saw. The tooth remains the same shape throughout, instead of having a constantly lessening chamber.

Fig. 212 shows part of a gullet tooth saw after cutting 300,000 feet of hemlock lumber. Line *D* and point *A* are the originals; line *E* and point *C* show a reduction of only $\frac{3}{14}$ inch in diameter.

In Fig. 213, tooth *B* has been rechambered; *A* shows, by the file applied flat to it, that it much needs that operation.

One maker had teeth like Fig. 214 sent to him to be gummed. *B* is the actual chamber line; it should have been *C*.

Fig. 208. Gumming Press.

The emery or corundum wheel does quick work in the highest tempered steels. It can be obtained of any desired edge section and used to dress the bottom, edge, back, or top of a tooth. It requires such

a high speed of revolution as to necessitate to use of power to run it; but part of this inconvenience is done away with by swinging it to an arbor above the mandrel, in the case of circular saws. Fig. 215 shows Bostwick's machine for the purpose.

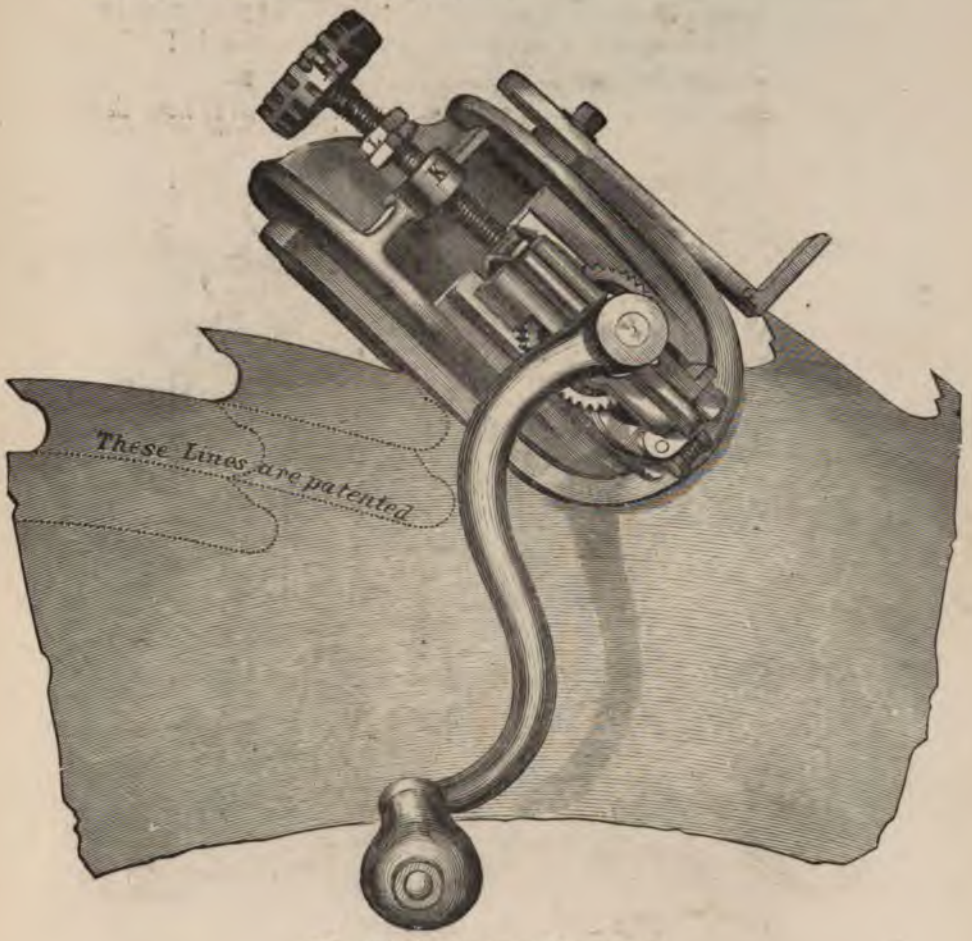


Fig. 209. Rotary Gummer.

There exists in the minds of many persons who are not fully acquainted with the principle upon which circular saws are made, an erroneous opinion that a saw should work the same until worn out, if it is not accidentally sprung in use or strained in gumming. So far as any damage to the saw is concerned, there is no difference between the use

of a burr gummer and that of a file; but if proper care be not exercised in the use of the emery wheel there is more danger from its use than from either the file or burr.

If the condition of the saw be such that a considerable depth is required to be cut into the plate, the operation should be performed by going over the saw several times, allowing the wheel to grind away only so much as can be done without heating the saw to a blue. There is no excuse whatever in crowding the emery wheel so as to heat the

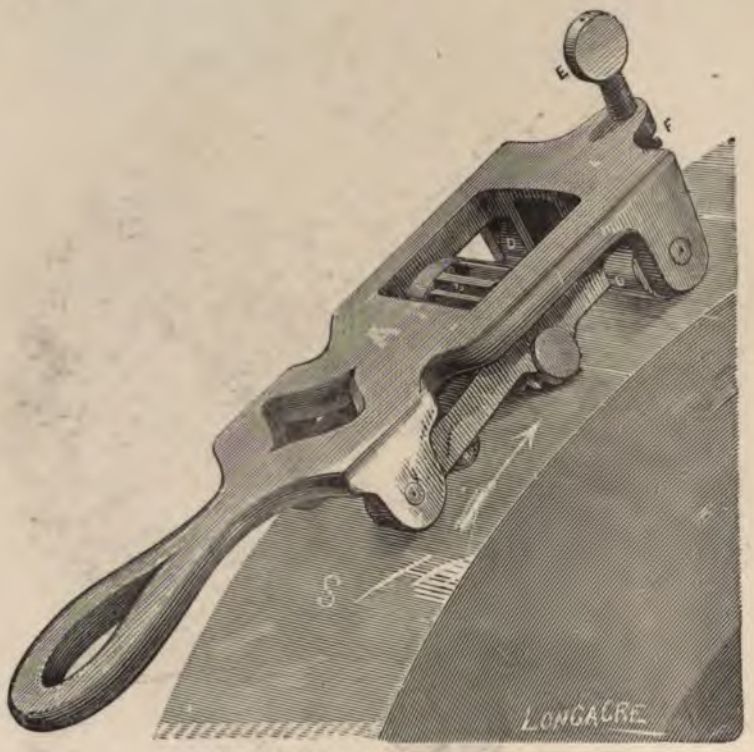


Fig. 210. Cutter Grinder.

saw red hot, as this is sure to injure the saw, often glazing it where the wheel comes in contact, so hard that a file will make no impression whatever. From these hard spots on the outer surface small cracks commence, at first invisible to the eye, but gradually enlarging until they become dangerous fractures. Hacking the face of the wheel with a cold chisel or the corners of an old file, will often prevent its glazing,

so that it is not as liable to heat the saw. After a few times gumming, however, the saw will enlarge on the rim so that the slightest warmth will cause it to buckle, and there is no remedy left but to send it to a saw maker and have it re-hammered. Some, however, entertain the wrong impression that a saw re-hammered will never run as well as when new. On the contrary, a saw re-hammered will generally run better than when new, because all the elasticity (or nearly all) is worked out of it by use, and it generally works stiffer than when new.

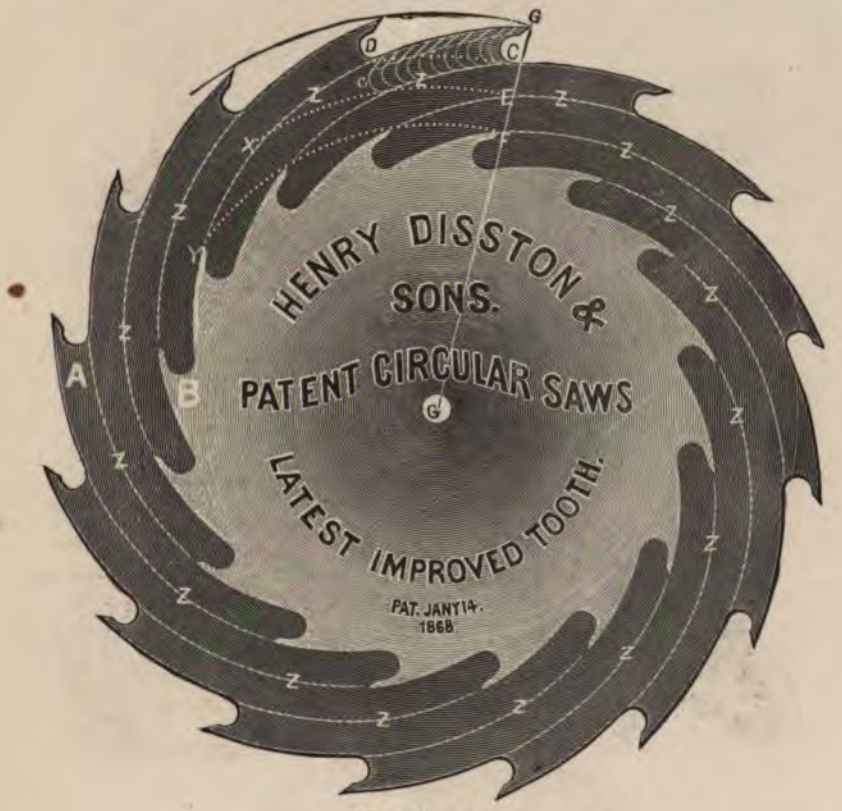



Fig. 211.

The cause of emery wheels hardening saw plates is stated by J. E. Emerson to be that the spaces between the particles of emery fill up with steel, creating a smooth instead of a rough surface. The friction quickly causes high heat, and sudden chilling takes place when the wheel leaves the spot. To remove it, hack the wheel with the corner

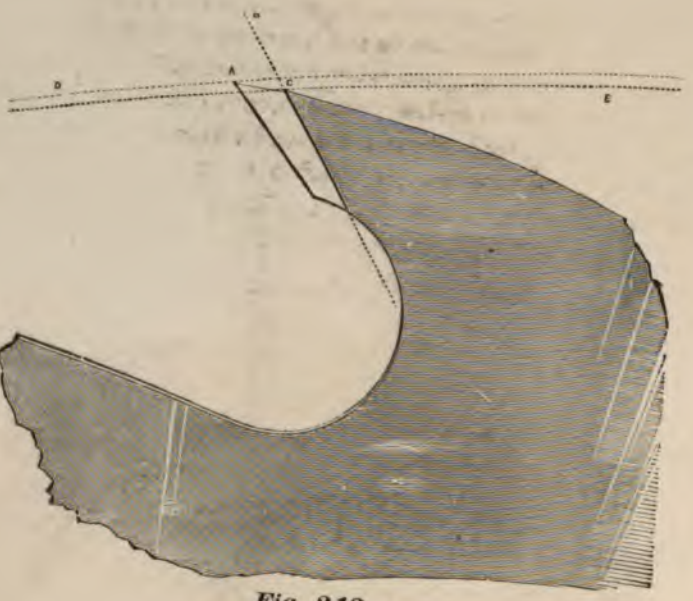


Fig. 212.

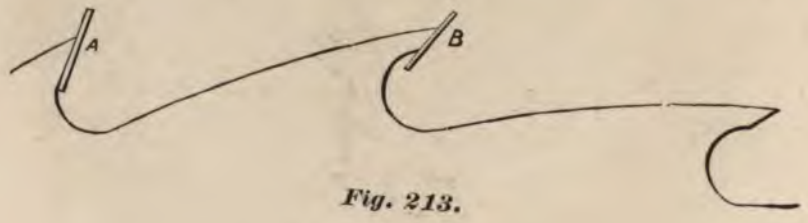


Fig. 213.

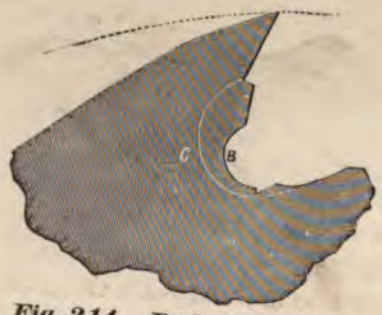


Fig. 214. Bad Gumming.

Fig. 215. Boswick's Emery Gummer.

of a worn out file, and grind off the extreme outer surface which has been hardened. It is better, and takes no longer to keep the emery wheel hacked and cut off only a little at a time and to go around the saw lightly several times in gumming.

The wheel is generally turned up true with a diamond after wear.

The great trouble in the use of the ordinary diamond tool is the danger of grinding out and losing the diamond. In the tool shown herewith the diamond *C* is held in copper, as shown at *D*. This copper is held between the two halves of the tool, which are firmly

Fig. 216. Emerson's Diamond Tool for Truing Wheels.

gripped together by the screws *BB*, the principle upon which the diamond is imbedded and held, holds it firmly and securely, being substantially the same as used in securing the diamonds in the Emerson Diamond Stone Saw.

A represents the diamond tool. *BB*, the screws for fastening the tool together with diamond *C* in the end. *D* represents a diamond in its casing, which is made of sheet copper on account of its toughness and pliability; this is fitted around and incorporated into every irregularity of the diamond, then the casing and diamond are fitted into the steel holder, and the fold of the copper casing held below the diamond firmly between the two jaws of the diamond tool or holder. In many other processes the diamond is held merely by a grip upon its own size; when the holder becomes worn to the centre of the diamond it drops out and is lost. By this process the casing is held, to which the diamond clings and is saved.

APPENDIX VII.

JOINING BAND SAW BLADES.

To make Muriate of Zinc (Chloride of Zinc; Zinc Chloride), *for Soldering or Brazing.*—Feed muriatic acid all the small pieces of zinc that it will eat; dilute with an equal amount of rain or distilled water (condensed steam water) and it is ready for use.

To Make Borax Water for Soldering or Brazing.—Burn a sufficient quantity of borax on a hot shovel or piece of sheet iron, or in an iron dish, then pulverize and boil in rain or condensed water to the consistency of cream.

To Join the Ends of a Band Saw.—File the ends of the saw on opposite sides to form two wedge-shaped ends, having a lap of say from $\frac{3}{4}$ to $1\frac{1}{2}$ inch, according to width and thickness of plate; a thin narrow plate for light work, like ordinary scroll sawing, $\frac{3}{4}$ inch: a wide saw, say four or five inches in width, by No. 16, 17 and 18 gauge, $1\frac{1}{2}$ inch lap. When the two beveled sides are laid together they must form a good joint of the same thickness as the blade. Now take two pairs of tongs with heavy jaws, long enough to cover the width of the blade; have the jaws straight and shut closely. Cut a notch in a piece of about 6 x 6 joist for wide saws, and smaller for narrow saws; have the notch large enough, and covered or plated inside, so that it will not be burned by the hot tongs. Next clamp the saw on the joists so that the laps will come over the notch; the joists should be say four feet in length, and mounted on legs like a carpenter's saw horse. Now cover the lap with the muriate of zinc or borax water, placing a piece of very thin silver solder or fine spelter solder in the joint; if spelter is used, it may be mixed with the borax water and spread between the joints (silver solder, however, is preferable to spelter). Now heat one pair

of the tongs to a bright cherry red and scrape off all the scale, etc., between the jaws; clamp the joint to be brazed, using another pair of cold tongs to clamp the points of the hot tongs, hold them a sufficient length of time to melt the solder, and have the other pair of tongs warmed to about the heat of a sad iron. Now carefully draw the hot tongs off towards the back of the saws, having the back rest firmly against supports, so that the saw cannot move edgewise. Have another person follow up the hot tongs with those merely warmed; hold the grip with the warm tongs until the joints are fairly set, when nothing remains to be done more than to file off the surplus solder. The above process will be found much better than cooling off the joints with water, which is liable to harden and crack the blade. The soldering and cooling tongs should be made heavy and strong. The cooling tongs should not be used entirely cold, as the sudden chilling will harden the plate. If the process is properly performed, the saw will be of the same temper at the splice as in other parts.

Figs. 217 and 218 show a very convenient device made by J. A. Fay & Co., Cincinnati, to facilitate the brazing of band-saw blades. It is sufficiently explained by the illustrations.

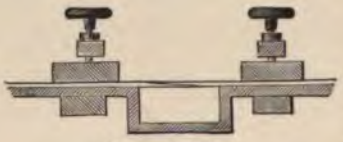
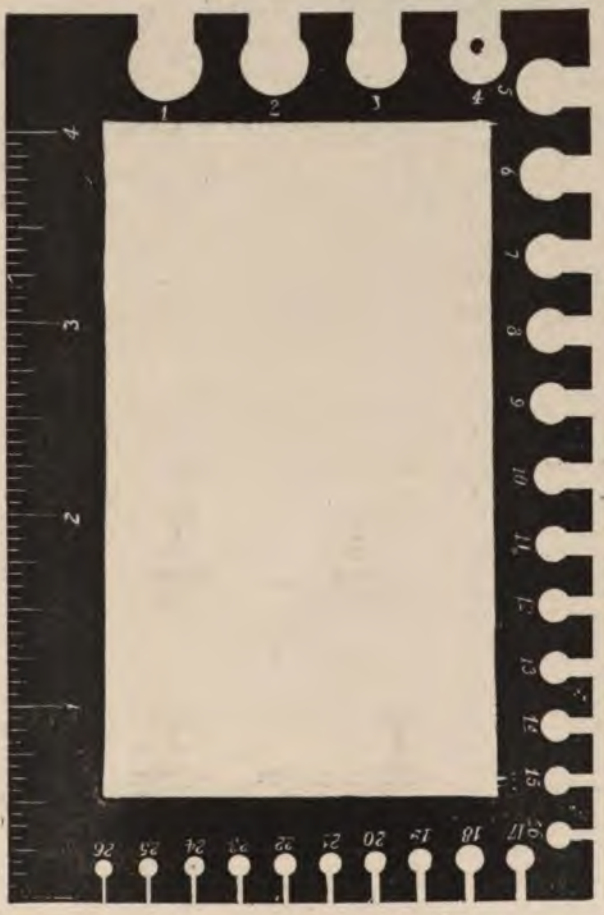


Fig. 217.

Fig. 218.

APPENDIX VIII.

Gauges and Measurements.



The gauge employed for measuring thickness of saw plates is the so-called "Stubs'," or Birmingham Wire Gauge (an arbitrary and senseless scale, almost matchless among trade stupidities), shown in part herewith in comparison with the inch and its divisions into sixteenths, and also given in part in decimal divisions of the inch in the annexed table:

Gauge.	Diam. Inch.	Gauge.	Diam. Inch.	Gauge.	Diam. Inch.
1	·3	10	·134	19	·042
2	·284	11	·12	20	·035
3	·259	12	·109	21	·032
4	·238	13	·095	22	·028
5	·22	14	·083	23	·025
6	·203	15	·072	24	·022
7	·18	16	·065	25	·02
8	·165	17	·058	26	·018
9	·148	18	·049		

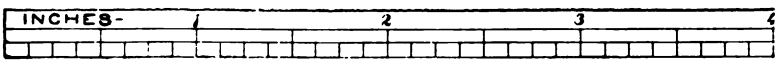
BIRMINGHAM WIRE GAUGE, EXPRESSED IN "CARPENTER'S MEASURE."

Gauge No. 4	$\frac{1}{4}$	inch scant.		Gauge No. 9	$\frac{5}{32}$	inch scant.	
" " 5	$\frac{7}{32}$	"		" "10	$\frac{1}{8}$	"	full.
" " 6	$\frac{3}{16}$	"	full.	" "11	$\frac{1}{8}$	"	scant.
" " 7	$\frac{3}{16}$	"	scant.	" "12	$\frac{1}{8}$	"	scant.
" " 8	$\frac{5}{32}$	"		" "13	$\frac{3}{32}$	"	

Table giving the values of inches and fractions of an inch in millimeteres:

Inches.	Millimetres.	Inches.	Millimetres.	Fractions of an inch.	Millimetres.	Fractions of an inch.	Millimetres.
1	25·39977	19	482·59567	$\frac{1}{32}$	0·79374	$\frac{17}{32}$	13·49362
2	50·79954	20	507·99544	$\frac{1}{16}$	1·58748	$\frac{9}{16}$	14·28737
3	76·19932	21	533·39521	$\frac{3}{32}$	2·38123	$\frac{19}{32}$	15·08111
4	101·59909	22	558·79499	$\frac{1}{8}$	3·17497	$\frac{5}{8}$	15·87485
5	126·99886	23	584·19476	$\frac{5}{32}$	3·96871	$\frac{21}{32}$	16·66859
6	152·39863	24	609·59453	$\frac{3}{16}$	4·76245	$\frac{11}{16}$	17·46234
7	177·79840	25	634·99430	$\frac{7}{32}$	5·55620	$\frac{23}{32}$	18·25608
8	203·19818	26	660·39407	$\frac{1}{4}$	6·34994	$\frac{3}{4}$	19·04982
9	228·59795	27	685·79385	$\frac{9}{32}$	7·14368	$\frac{25}{32}$	19·84356
10	253·99772	28	711·19362	$\frac{5}{16}$	7·93743	$\frac{13}{16}$	20·63731
11	279·39749	29	736·59339	$\frac{11}{32}$	8·73117	$\frac{27}{32}$	21·43105
12	304·79726	30	761·99316	$\frac{3}{8}$	9·52491	$\frac{7}{8}$	22·22479
13	330·19704	31	787·39293	$\frac{13}{32}$	10·31865	$\frac{29}{32}$	23·01853
14	355·59681	32	812·79271	$\frac{7}{16}$	11·11240	$\frac{15}{16}$	23·81228
15	380·99658	33	838·19248	$\frac{15}{32}$	11·90614	$\frac{31}{32}$	24·60602
16	406·39635	34	863·59225	$\frac{1}{2}$	12·69988	1	25·39977
17	431·79612	35	888·99202				
18	457·19590	36	914·39179				

We annex a cut showing four inches graduated to centimetres:



APPENDIX IX.

ORDERING CIRCULAR SAWS.

In ordering circular saws for log sawing, it is always necessary, to avoid error or delays, to give the following data:

1. Whether inserted or solid toothed saws. 2. Diameter of saw in inches. 3. Kind and number of teeth (see Fig. 91.) 4. Gauge of saw at the hole. 5. Gauge of saw at the rim. 6. Size of centre hole. 7. Size of pin holes. 8. Diameter of circle pin holes are on (distance from centre to centre). 9. Which is the log side as the saw runs towards you, right or left? 10. Speed the saw is to run per minute. 11. What kind of timber you wish to cut. 12. Largest feed to each revolution of the saw, in inches. 13. Number of extra teeth desired if inserted teeth be ordered. 14. How it is to be shipped, whether by freight or express.

When ordering shingle saws, send correct draft holes, whether flange is on right or left side (saw cutting towards you), thickness at tooth, and about the number of teeth.

When ordering concave saws, give circle to be dished to; also, which side is to be dished or concaved, the right or left hand (saw running towards you).

APPENDIX X.

Tables for the Measurement of Logs, from 12 to 24 feet long and from 10 to 96 inches in Diameter.

[These tables are given here by special permission of the owners of the copyright, Messrs. N. W. Spaulding & Bros., Chicago.]

EXPLANATION.

The length of any log in feet will be found in the left hand column of the table, and the diameter at the top of the page.

To find the number of feet of square-edged boards which a log will produce when sawed: Take the length in feet in left hand column of table, and its diameter in inches at the top of the page; trace the two columns of figures until they meet, and you have the required amount.

EXAMPLE.

A log which is 18 feet long and 21 inches in diameter gives, at the right of the length and directly under the diameter, 346 feet.

And one 23 feet long and 18 inches in diameter gives 310 feet.

Logs longer than is given in this table can be easily measured by doubling any given length; for example, to find the number of feet, board measure, contained in a log 28 feet long by 19 inches in diameter, double the amount contained in a log 14 feet long, 19 inches diameter, and you have the answer—428 feet. For a log 42 feet long, 10 inches diameter, multiply the amount contained in the table in a log 14 feet long by three, and you have the amount; and so on to any length or size.

REMARKS.

In placing these tables before the Lumbermen, we wish to draw their attention to the fact that they have been computed from accurately drawn diagrams of every sized log from 10 to 96 inches in diameter. Each sized log has been scaled, so as to make all that can be practically sawed out of it, if economically sawed. Each log to be measured at the top or small end, inside of the bark, and, if not round, to be measured two ways—at right angles—and the difference taken for the

diameter. Where there are any known defects, the amount to be deducted should be agreed upon by the buyer and seller, and no fractions of an inch to be taken into the measurement.

In this table we have varied the size of the slab in proportion to the size of the log, and have arranged it more particularly for large logs, by taking them in sections of 12 feet and carrying the table up to 96 inches in diameter. As there has never been any in use for scaling over 44 inches, it has been our purpose to furnish a table for the measuring of logs that can be implicitly relied upon for correctness by both buyer and seller; and to do so, we have spared no pains nor expense to render it perfect.

Length in Feet.	Diam. 10	Diam. 11	Diam. 12	Diam. 13	Diam. 14	Diam. 15	Diam. 16	Diam. 17	Diam. 18	Diam. 19	Diam. 20
12.....	38	47	58	71	86	103	121	141	162	184	207
13.....	41	51	62	76	93	111	131	152	175	199	224
14.....	44	55	67	82	100	120	141	164	189	214	241
15.....	47	59	72	88	107	128	151	176	202	230	258
16.....	50	63	77	94	114	137	161	188	216	245	276
17.....	53	67	82	100	121	145	171	199	229	260	293
18.....	57	70	87	106	129	154	181	211	243	276	310
19.....	60	74	91	112	136	163	191	223	256	291	327
20.....	63	78	96	118	143	171	201	235	270	306	345
21.....	66	82	101	124	150	180	211	246	283	322	362
22.....	69	86	106	130	157	188	221	258	297	337	379
23.....	72	90	111	136	164	197	231	270	310	352	396
24.....	76	94	116	142	172	206	242	282	324	368	414

Length in Feet.	Diam. 21	Diam. 22	Diam. 23	Diam. 24	Diam. 25	Diam. 26	Diam. 27	Diam. 28	Diam. 29	Diam. 30	Diam. 31
12.....	231	256	282	309	337	366	396	427	459	492	526
13.....	250	277	305	334	365	396	429	462	497	533	569
14.....	269	298	329	360	393	427	462	498	535	574	613
15.....	288	320	352	387	421	457	495	533	573	615	657
16.....	308	341	376	412	449	488	528	569	612	656	701
17.....	327	362	399	437	477	518	561	604	650	697	745
18.....	346	384	423	463	505	549	594	640	688	738	789
19.....	365	405	446	489	533	579	627	676	726	779	832
20.....	385	426	470	515	561	610	660	711	765	820	876
21.....	404	448	493	540	589	640	693	747	803	861	920
22.....	423	469	517	566	617	671	726	782	841	902	964
23.....	442	490	540	592	645	701	759	818	879	943	1008
24.....	462	512	564	618	674	732	792	854	918	984	1052

Length in Feet.	Diam. 32	Diam. 33	Diam. 34	Diam. 35	Diam. 36	Diam. 37	Diam. 38	Diam. 39	Diam. 40	Diam. 41
12	561	597	634	673	713	755	798	843	889	936
13	607	646	686	729	772	817	864	913	963	1014
14	654	696	739	785	831	880	931	983	1037	1092
15	701	746	792	841	891	943	997	1053	1111	1170
16	748	796	845	897	950	1006	1064	1124	1185	1248
17	794	845	898	953	1010	1069	1130	1194	1259	1326
18	841	895	951	1009	1069	1132	1197	1264	1333	1404
19	888	945	1003	1065	1128	1195	1263	1334	1407	1482
20	935	995	1056	1121	1188	1258	1330	1405	1481	1560
21	981	1044	1109	1177	1247	1321	1397	1475	1555	1638
22	1028	1094	1162	1233	1307	1384	1463	1545	1629	1716
23	1075	1144	1215	1289	1366	1447	1529	1615	1703	1794
24	1122	1194	1268	1346	1426	1510	1596	1686	1778	1872

Length in Feet.	Diam. 42	Diam. 43.	Diam. 44	Diam. 45	Diam. 46	Diam. 47	Diam. 48	Diam. 49	Diam. 50	Diam. 51
12	984	1033	1086	1134	1186	1239	1293	1348	1404	1461
13	1066	1119	1176	1228	1284	1342	1400	1460	1521	1582
14	1148	1205	1267	1323	1383	1445	1508	1572	1638	1704
15	1230	1291	1357	1417	1482	1548	1616	1685	1755	1826
16	1312	1377	1448	1512	1581	1652	1724	1797	1872	1948
17	1394	1463	1538	1606	1680	1755	1831	1909	1989	2069
18	1476	1549	1629	1701	1779	1858	1939	2022	2106	2191
19	1558	1635	1719	1795	1877	1961	2047	2134	2223	2313
20	1640	1721	1810	1890	1976	2065	2155	2246	2340	2435
21	1722	1807	1900	1984	2075	2168	2262	2385	2457	2556
22	1804	1893	1991	2079	2174	2271	2370	2470	2574	2678
23	1886	1979	2081	2173	2273	2374	2478	2582	2691	2800
24	1968	2066	2172	2268	2372	2478	2586	2696	2808	2922

Length in Feet.	Diam. 52	Diam. 53	Diam. 54	Diam. 55	Diam. 56	Diam. 57	Diam. 58	Diam. 59	Diam. 60	Diam. 61
12	1519	1578	1638	1700	1763	1827	1893	1960	2028	2098
13	1645	1709	1774	1841	1909	1979	2050	2123	2197	2272
14	1772	1841	1911	1983	2056	2131	2208	2286	2366	2447
15	1898	1972	2047	2125	2203	2283	2366	2450	2535	2622
16	2025	2104	2184	2266	2350	2436	2524	2613	2704	2797
17	2151	2235	2320	2408	2497	2588	2681	2776	2873	2972
18	2278	2367	2457	2550	2644	2740	2839	2940	3042	3147
19	2405	2498	2593	2691	2791	2892	2997	3103	3211	3321
20	2531	2630	2730	2833	2938	3045	3155	3266	3380	3496
21	2657	2761	2866	2974	3085	3197	3312	3429	3649	3671
22	2784	2893	3003	3116	3232	3349	3470	3592	3718	3846
23	2911	3024	3139	3258	3379	3501	3628	3756	3887	4021
24	3038	3156	3276	3400	3526	3654	3786	3920	4056	4196

Length in Feet.	Diam. 62	Diam. 63	Diam. 64	Diam. 65	Diam. 66	Diam. 67	Diam. 68	Diam. 69	Diam. 70	Diam. 71	Diam. 72
12.....	2169	2241	2315	2390	2467	2545	2625	2706	2789	2874	2960
13.....	2349	2427	2507	2589	2672	2757	2843	2931	3021	3113	3206
14.....	2530	2614	2700	2788	2878	2969	3062	3157	3253	3353	3453
15.....	2711	2801	2893	2987	3083	3181	3281	3382	3486	3592	3700
16.....	2892	2988	3086	3186	3289	3393	3500	3608	3718	3832	3946
17.....	3072	3174	3279	3385	3494	3605	3718	3833	3951	4071	4193
18.....	3253	3361	3472	3585	3700	3817	3937	4059	4183	4311	4440
19.....	3434	3548	3665	3784	3906	4029	4156	4284	4415	4550	4686
20.....	3615	3735	3853	3983	4111	4241	4375	4510	4648	4790	4933
21.....	3795	3921	4051	4182	4316	4453	4593	4735	4880	5029	5180
22.....	3976	4108	4244	4381	4522	4665	4812	4961	5113	5269	5426
23.....	4157	4295	4437	4580	4728	4877	5031	5186	5345	5508	5673
24.....	4338	4482	4630	4780	4934	5090	5250	5412	5578	5748	5920

Length in Feet.	Diam. 73	Diam. 74	Diam. 75	Diam. 76	Diam. 77	Diam. 78	Diam. 79	Diam. 80	Diam. 81	Diam. 82	Diam. 83	Diam. 84
12	3047	3135	3224	3314	3405	3497	3590	3684	3779	3874	3970	4067
13	3301	3396	3492	3590	3688	3788	3889	3991	4094	4196	4301	4406
14	3555	3657	3761	3866	3972	4080	4188	4298	4408	4519	4631	4745
15	3809	3919	4030	4142	4256	4371	4487	4605	4723	4842	4962	5084
16	4062	4180	4298	4418	4540	4663	4786	4912	5038	5165	5293	5423
17	4316	4441	4567	4694	4823	4954	5085	5219	5353	5488	5624	5762
18	4570	4702	4836	4970	5107	5245	5385	5526	5668	5811	5955	6101
19	4824	4964	5104	5246	5391	5537	5684	5833	5983	6133	6285	6440
20	5078	5225	5372	5522	5675	5829	5983	6140	6298	6456	6616	6778

Length in Feet.	Diam. 85	Liam. 86	Diam. 87	Diam. 88	Diam. 89	Diam. 90	Diam 91	Diam. 92	Diam. 93	Diam. 94	Diam. 95	Diam. 96
12	4165	4264	4364	4465	4566	4668	4771	4875	4980	5085	5192	5300
13	4512	4619	4727	4837	4946	5057	5168	5281	5395	5508	5624	5741
14	4859	4974	5091	5209	5327	5446	5566	5687	5810	5932	6057	6183
15	5206	5330	5455	5581	5707	5835	5964	6094	6225	6356	6490	6625
16	5553	5685	5818	5953	6088	6224	6361	6500	6640	6780	6922	7066
17	5900	6040	6182	6325	6468	6613	6759	6906	7055	7203	7355	7508
18	6247	6396	6546	6697	6849	7002	7156	7312	7470	7627	7788	7950
19	6594	6751	6909	7069	7229	7391	7554	7719	7885	8051	8220	8391
20	6941	7106	7273	7441	7610	7780	7951	8125	8300	8475	8653	8833

APPENDIX XI.

Data Concerning Capacity of Saw Mills and Power Required to Run them.

[Unless otherwise stated, widths of straight saws and diameters of circulars, thickness of log or height of cant, belt widths and pulley diameters, tooth height and distance, and kerf width, are stated in inches.]

DATA—SINGLE SASH SAW.

Length—feet.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood (slitting).	Height of cant.	Feed—lineal feet per minute.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Height of teeth.	Distance between teeth.	Width of kerf.	Capacity—10 hours.	Informant.
7	8	9		175		24			Doub.	12				2	1/4	3 M	Emerson, Smith & Co.
6	8	10 & 12	24	200	Pine	14		40	Doub.	14	48	200	1 1/2	2	5/16	10 to 12 M	Stearns & Co.
6 1/2	8	6 or 7	28	220	Pine		1/2	12	Doub.	10	24	120	1 1/2	2	1/4	2 M *	E. Andrews.

* Inch boards.

DATA—GANG SASH SAW.

Number of saws.	Length—feet.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood (slitting).	Height of cant.	Feed, per stroke—inches.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Pulley revolutions per minute.	Height of teeth.	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
40	5	8	13		175	Pine		3/4									75 to 100 M	Emerson, Smith & Co.
42	4	15		20	240	Pine	12	3/4	80					1 1/4	1 1/8	1/4	100 M	Stearns & Co.
28	4 1/2		11 or 12	24	180	Pine		3/4	24	Doub.	14	36	180	1 1/4	1 1/2	5/16	25 M*	E. Andrews.
34	5 1/2	9	12 & 13	20	200	Maple	28	5/8	50	Doub.	26	42	200	1 1/8	1 1/2	5/16	60 M	D. B. McRae.
21	3 1/2	7	13	20	300			5/8	70	Doub	24	48	300	1	1 1/2	5/16	80 M	F. McDonough.
39	5 1/2	10	12	12	150	Pine	26	3/4 to 1 1/4		Doub	20	36		1 1/4	1 1/2	1/4		C. D. Hale.
27	5 1/4	8	11	24					25	Doub.	20	36	200		1 1/2	5/32	60M	Anoka Lumber Mills.
30	5	7	11 to 12	22	200		12	5/8	35	Doub.	16	42	200	1 1/4	1 3/4	3/8	35 M	Snyder Bros.

* Inch boards.

DATA—MULAY SAW.

Length—feet.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood.	Height of cant—inches.	Feed—per stroke.	H. P. required.	Kind of belt.	Width of belt—inches.	Diameter of pulley—inches.	Height of teeth.	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
7	12	7	28	225	Pine		3/4	15	Doub.	14	30	1 3-32	2	1/4	5 M*	E. Andrews.
7	8	6 & 7	18	180		25	5/8	30	Doub.	14	36	1 1/2	2	3/16	12to15M	D. B. McRae.
7	10	7	24	325		30	1 1/4	14	Doub.	14	30	1 1/2	2	1/4		Snyder Bros.

* Inch boards

DATA—JIG SAW—SPRING STRAINED.

Width—inches.	Gauges.	Width of Kerf.	Stroke—inches.	Revolutions per minute.	Kind of wood.	Height of cut.	Height of teeth.	Distance of teeth.	Informant.
1/4	14 &16	3-32	5	1100	Bl'k Walnut	2 1/2	1/8	3/16	J. A. Fay & Co.

DATA—DRAG OR BUTTING SAW.

Length—feet.	Width—heel.	Width—point.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of logs (cross cutting).	Thickness of logs.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Height of teeth.	Distance of teeth.	Width of kerf.	Single or double cutting.	Informant.
6	10	6	9 & 10	24	120			5	Single.	8	24	120		1 1/4	3/16	Double.	E. Andrews.
6	6	4	13 & 16	36	40		*					40				Double.	W. W. Giles.
6	10	6	9	28	100	36	5	Double.	6	20	100		1 1/4	1 1/4	1/4	Double.	Snyder Bros.

*"Riding" Drag Saw—Man Power.

DATA—BAND SCROLL SAW.

Length—feet.	Width—inches.	Gauge.	Diameter of wheels—inches.	Revolutions per minute.	Velocity per minute—feet.	Kind of wood.	Height of wood—inches.	Width of kerf.	Height of teeth.	Distance of teeth.	Informant.
20	5/8	20	40	350	3665		2	3-64	3-32	1/4	J. A. Fay & Co.
18 1/2	3/4										Anoka Lum. M.

DATA—BAND RESAW.

Length—feet.	Width—inches.	Gauges.	Diameter of wheels—inches.	Revolutions per minute.	Lineal velocity per minute—feet.	Kind of wood (slitting).	Height of cant—inches.	Feed—Lineal feet per minute.	H. P. required.	Kind of belt.	Width of belt—inches.	Pulley diameter—inches.	Pulley revolutions per minute.	Height of teeth	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
28½	4	18	60	400	6283	Poplar	20	25	12	Single	8	30	400	½	1½	⅛	10 M	J. A. Fay & Co.
40	5	16	72	350			24 to48	30	15	Doub. or Single	10	30	350	1	2	¼	20 M*	J. H. Hoffman.

* Inch boards.

DATA—SINGLE CIRCULAR SAW.

Kind of teeth.	Diameter—inches.	Gauge at eye.	Gauge at rim.	Number of teeth.	Revolutions per minute.	Feed—inches per revolution.	Kind of wood.	Height of cant	Width of kerf.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Capacity—10 hours.	Informant.
Solid	56	5	7	48	600	3½			¼	30	Single	14	24	600	12 M*	E. Andrews.
Solid	60	7	8	60	850	†	Pine		⅛		Single	16			50 M	Wyman, Buswell & Co.
Inserted	72	6	8	72	680	12	Pine	16	¼	80	Doub.	18	23	265	50 M	D. B. McRae.
Solid	60	4	8	64	850	6	Pine		¼	80	Doub.	20	30	850	55 M	F. McDonough.
Solid or Inserted	66	5	7	56	500	6	Pine		¼		Doub.	16				
Inserted	60	6	7	34	400 to 450	2	Pine and Hemlock	30		25	‡				8to 13 M	Waterous Engine Wks.
Solid or Inserted	58	5	6	44	650	4	Pine		¼	20	Doub.	18			50 M	Anoka Lumber Mills.

* Inch boards. † Unlimited; "Shot-gun" steam feed.
‡ Running direct action every revolution of engine being one of saw.

Disston states that for 10,000 feet per day 20 HP are required; for 20,000 feet, 30 HP; for 30,000 feet, 40 HP.

To run a 60-inch circular through a 24-inch hemlock or oak log requires ordinarily, according to Emerson, about 10 HP to every one inch of feed in the revolution of the saw.

Years ago 48-inch circular saws were used in our Western States, driven by four horses walking around; these sawed 500 to 1200 feet of lumber a day, according to kind and quality of logs.

APPENDIX XII.

RESULTS OF EXPERIMENTS

Made with CIRCULAR SAWS *at Cincinnati Industrial Exposition*, 1874, *by* CHAS. A. BAUER, *Mechanical Engineer.*

NAME.	Kind of Lumber Sawed	SAW. Diameter in Inches	Revolutions per Minute	Number of Teeth	GAUGE. Eye	Teeth	Face	Feed	Cut per Tooth	Size of Board Sawed	Number of Boards Sawed	Square Feet of Lumber Sawed	Time	Indicated Horse-Power	Square Feet of Lumber Sawed per Minute	Percentage of Power Used	General Percentage of Power Used
Hogan & Snowden	Poplar	56	600	42	7	11	3	2 1/16	·0600	20x12	16	300	2·50	76·4	105·8	·592	·592
E. Andrews	Poplar	56	648	40	5	7	3	3 3/32	·0844	20x12	16	300	2·53	89·6	104·	·705	·7435
E. Andrews	Oak...	56	660	40	5	7	3	2 1/32	·0625	16x12	12	176	2·05	80·5	84·4	·782	
J. W. Baldridge & Co	Poplar	56	640	48	8	9	4	2 1/32	·0521	20x12	16	300	2·53	79·4	104·	·635	·7705
J. W. Baldridge & Co	Oak...	56	690	48	8	9	4	2 1/32	·0521	16x12	12	176	2·03	74·9	85·8	·906	
American Saw Company	Poplar	56	634	40	6	8	3	3 3/32	·0844	20x12	16	300	2·31	83·9	119·5	·576	·6595
American Saw Company	Oak...	56	628	40	6	8	3	2 1/16	·0625	16x12	12	176	2·02	78·4	86·5	·743	
Emerson, Ford & Co	Poplar	26	615	50	6	7	3	3 3/32	·0675	20x12	16	300	2·44	96·1	109·7	·718	·748
Emerson, Ford & Co	Oak...	56	620	50	6	7	3	3 3/32	·0675	16x12	12	176	1·43	97·3	102·5	·778	
Emerson, Ford & Co., *planer tooth*	Poplar	56	590	34	7	8	3	2 1/32	·0735	20x12	16	300	3·17	93·8	91·3	·843	·9215
Emerson, Ford & Co., *planer tooth*	Oak...	56	632	34	7	8	3	2 1/32	·0735	16x12	12	176	2·27	87·6	71·8	1·000	
Woodrough & McParlin	Poplar	56	656	40	7	8	5	3 3/32	·0844	20x12	16	300	2·34	90·3	116·9	·633	·683
Woodrough & McParlin	Oak...	56	636	40	7	8	5	3 3/32	·0844	16x12	12	176	1·45	91·4	100·5	·745	
R. Hoe & Co	Poplar	56	519	36	5	8	2	4 1/32	·1250	20x12	16	300	2·09	89·7	139·5	·527	·527
R. Hoe & Co., *planer tooth*	Poplar	56	605	36	5	7	2	3 3/32	·0938	26x12	16	300	2·45	91·8	109·1	·689	·7045
R. Hoe & Co., *planer tooth*	Oak...	56	602	36	5	7	2	2 1/4	·0694	10x12	12	176	1·58	79·	90·	·720	
James Ohlen	Poplar	56	634	30	6	7	3	4 1/32	·1500	26x12	16	300	2·53	82·	104·	·648	·734
James Ohlen	Oak...	56	638	30	6	7	3	3 3/32	·1160	10x12	12	176	1·59	82·7	88·8	·820	
Curtis & Co	Poplar	56	681	50	8	10	6	3 3/32	·0700	26x12	16	300	2·51	65·	105·2	·597	·727
Curtis & Co	Oak...	56	640	50	8	10	6	2 1/2	·0500	10x12	12	176	2·30	81·1	70·4	·945	

The power to drive saws was furnished by a 14x20 engine.

APPENDIX XIII.

Alphabetical List of U. S. Saw Patents from 1790 to Nov. 15, 1879.

Saw	S. Anderson,	May 5, 1868,	77,439
	E. Andrews,	Dec. 79, 1868,	85,417
	" "	Jan. 24, 1871,	111,164
	J. E. Atwood,	Dec. 11, 1866,	60,321
	" "	Nov. 12, 1867,	70,680
	J. G. Baker,	June 23, 1868,	79,185
	S. Barry,	June 23, 1868,	79,099
	A. Bee,	Jan. 1, 1867,	69,827
	A. Boynton,	Nov. 27, 1866,	59,951
	E. M. Boynton,	Jan. 14, 1868,	73,226
	W. E. Brooks,	Sep. 20, 1870,	107,293
	H. Broomell & A. W. Wilson,	May 3, 1870,	102,653
	C. N. Brown,	Dec. 10, 1872,	133,828
	I.S &C.N.Brown,	Oct 24, 1865,	50,553
	" " "	Jan. 29, 1867,	61,513
	" " "	Mar. 12, 1867,	62,813
	" " "	Apr. 7, 1868,	76,395
	" " "	Nov. 2, 1869,	96,305
	B. F. Burgess,	Sep. 22, 1868,	82,289
	E. Clark,	Apr. 3, 1849,	6,258
	W. Clemson,	Aug, 14, 1866,	57,088
	" "	Mar. 24, 1868,	75,733
	" "	Mar. 16, 1869,	87,910
	S. Cook,	July 22, 1873,	141,036
	H. Cramer,	Oct. 19, 1869,	95,884
	R. Cromelien,	Mar. 28, 1865,	46,996
	S. Crookes,	July 22, 1873,	141,122
	P. Crosby,	Apr. 10, 1860,	27,779
	J. Davis,	Jan. 7, 1868,	72,983
	A. Dawes,	June 27, 1865,	48,376
	H.P.Dillingham,	Dec. 5, 1865,	51,385
	C. Disston,	Mar. 19, 1867,	63,024
	"	Apr. 2, 1867,	63,486
	"	May 21, 1867,	64,953
	"	Aug, 11, 1868,	80,929
	H Disston,	Oct. 4, 1870,	108,011
	"	Feb. 28, 1871,	112,227
	H. Disston & I. O. Hill,	Feb. 7, 1871,	111,619
	E. S. Drake,	Apr. 11, 1865,	47,255
	W. L. Earing,	Nov. 7, 1871,	120,633
	J. E. Emerson,	Mar. 20, 1860,	27,537
	"	July 3, 1866,	56,142
	"	Aug. 28, 1866,	57,627
	"	Feb. 12, 1867,	62,020
	"	Mar. 26, 1867,	63,232
	"	July 16, 1867,	66,692
	"	Feb. 18, 1863,	74,521
	"	May 3, 1870,	102,520
	"	Mar. 14, 1871,	112,569
	"	Apr. 25, 1871,	113,992
	"	June 27, 1871,	116,421
	"	Feb. 6, 1872,	123,466
	J. E. Emerson & W. S. Winsor	Feb. 18, 1868,	74,522
	"	" "	74,523
	W. L. Gage,	Jan. 17, 1871,	110,966
Saw	G. B. Goodnow,	Mar. 29, 1870,	101,258
	G. B. Green,	Sep. 12, 1871,	118,800
	J. Holden,	Mar. 5, 1872,	124,268
	E. Humphrey,	Feb. 18, 1868,	74,541
	J. Huther,	Jan. 2, 1872,	122,320
	M. W. Geffords,	Aug. 22, 1871,	118,370
	N. Jenkins,	Feb. 2, 1869,	86,407
	M. Jincks	Mar. 19, 1872,	124,825
	N. Johnson,	Nov. 12, 1872,	133,036
	H. Knowles,	Aug. 27, 1850,	7,603
	J. L. Kranser,	Dec. 3, 1867,	71,625
	H. A. Lanman,	July 20, 1869,	92,846
	J. Lippincott,	Mar. 13, 1866,	53,157
	"	June 5, 1866,	55,423
	C. V. Littlepage,	Apr. 26, 1870,	102,286
	"	Dec. 19, 1871,	121,950
	J.K.Lockwood,	Nov. 12, 1867,	70,728
	V.Luppert & P. St. Pierre,	Aug. 19, 1873,	144,939
	T. P. Marshall,	May 7, 1872,	126,407
	A. C. Martin & J. Woodrough	Jan. 8, 1867,	61,014
	E. Marx,	Nov. 4, 1873,	144,341
	G. Maulick,	Feb. 9, 1869,	86,850
	"	July 12, 1870,	105,349
	E. Miall, jr.,	June 29, 1869,	92,080
	W. P. Miller,	Oct. 9, 1866,	58,664
	"	Sep. 1, 1868,	81,811
	"	" "	81,812
	W.F.Milliman,	Oct. 4, 1870,	108,040
	C.Mitzelfield,	Aug. 9, 1870,	106,187
	G.B.Montgom'y,	Aug.25,1868,	81,525
	J. Neal,	June 11, 1867,	65,687
	J. Phillips,	Sep. 27, 1870,	107,808
	D. Ricker,	Oct. 17, 1871,	119,998
	E.J.Robinson,	Sep. 25, 1866,	58,297
	D. Sattler,	Aug. 25, 1868,	81,413
	"	Nov. 14, 1871,	121,007
	S. Schofield,	May 27, 1873,	139,426
	S. W. Shailer,	July 12, 1870,	105,261
	C.T.Shoemaker,	June 5, 1866,	55,375
	J. Smith,	Oct. 4, 1870,	107,059
	J. H. Smith & E. G. Peckham,	Sep.21, 1879,	95,052
	N.W. Spaulding,	Sep.10, 1861,	33,270
	A. P. Sproul,	Dec. 10, 1872,	133,810
	W.R.Stephenson,	Jul. 30,1867,	67,369
	L. Stewart,	May 16, 1854,	10,932
	D. Talbot,	Oct. 2, 1860,	30,265
	P. Thompson,	Aug. 8, 1871,	117,944
	E. W. Tilton,	Apr. 2, 1867,	63,581
	J. H. Tuttle,	Jun. 21, 1853,	9,807
	W. G. Tuttle,	Jan. 6, 1863,	37,312
	"	Mar. 3, 1863,	37,835
	J. P. Tyler,	Juy. 20, 1869,	92,909
	G. Walker,	Jan. 7, 1868,	73,210
	J. L. Warren,	Dec. 8, 1868,	84,722
	T. Welham,	Jan. 3, 1871,	110,705

Saw.....J. Woodrough, May 15, 1866, 54,827
Saw & SawTeeth, J.M.Johnston, May 25, 1869, 90,365
Back, W. Clemson, Oct. 17, 1871, 119 967
Band, C. A. Young, Jun. 3, 1873, 139,644
Belt, D.A.Cameron, Mar. 21, 1854, 10,678
W. Carey, Feb. 17, 1836,
G. Thompson, Aug. 25, 1868, 81,434
or Band, A. Stewart, July 5, 1817,
Timber, B. Barker, Jan. 6, 1836,
Buhl T. Leavitt, Dec. 13, 1870, 110,051
Chain, D. Kennedy, Feb. 4, 1868, 74,097
Circular, S. Bonnel, Sep. 26, 1823,
H. Disston, Jan. 14, 1868, 73,238
J. E. Emerson, Apr. 13, 1869, 88,949
J. F. Folmar, Aug. 18, 1868, 81,267
J. Glove, Oct. 16, 1839, 1,372
W. F. Hill, July 11, 1818,
L. Hitchcock, Jun. 29, 1833,
W.Kendall, jr., May 18, 1826,
J. Weille & H.S.Robinson, Mar.16,1869, 87,891
Circ.or Cyln'l, L. R Bump, Aug. 29, 1828,
Reacting, W. Avery, Dec. 8, 1826,
Revolv'g, T. Howe, Feb. 19, 1829,
Stone, R. Deering, sr., Oct. 3, 1854, 11,746
Cross-cut, W. Clemson, Aug. 22, 1871, 118,198
S. S. Disston, Jan. 21, 1868, 73,516
P. Longwell, July 26, 1870, 105,704
A.M.Leabury, Nov. 19, 1867, 71,227
Circ. A. H. Foote, July 14, 1830,
Comp.Rotary, A. Stewart, Sep. 29, 1825,
Cr'-cut Steam, L. Kefrk, Mar. 27, 1847, 5,040
Cylindrical, C. Murdock, Dec. 25, 1868, 85,021
Drag, J. Bailey, Jun. 30, 1863, 39,028
W. A. Purves, Apr. 21, 1863, 38,264
Hand, J. F. Allen, Dec. 24, 1867, 72,582
R. M. Breckenridge, Jan. 23, 1866, 52,131
T. S. Disston, Sep. 23, 1873, 143,128
A. W. Elmer, July 16, 1867, 66,690
J. E. Emerson, Sep. 22, 1868, 82,299
J. Gorham, May 13, 1856, 14,863
J. Jennings, Apr. 17, 1809,
O. H. Langdon, May 30, 1871, 115,328
W.H.Livingston, Apr.23, 1867, 64,118
T. D, Roberts, Apr. 28, 1863, 38,338
E. R. Rae, June 25, 1867, 66,174
D. Welch & W. W. Armington, Oct.24'1865, 50,667
Wood, C. M. Day, Oct. 9, 1866, 58,616
Ice, J. Barker, Feb. 3, 1838, 590
S. Scotton, Dec. 2, 1856, 16,152
Jack, A. Whitlock, Aug. 16, 1870, 106,438
Jig, I. B. Arthur, Mar. 23, 1869, 88,114
L. M. Berry& N. S. Graves, Jan. 5, 1864, 41,116
T. Blandin, June 21, 1870, 104,410
J.E.Chamberlin, Oct.27, 1868, 83,362
B. Merritt, Jan. 14, 1873. 134,760
C. D. Moore, Aug. 15, 1871, 118,041
A. F. Shaw, Feb. 9, 1864, 41,539
M. E. Weller, Oct. 14, 1873, 143,650
A. H. Whitney, Aug. 15, 1871, 118,087
Meat, P. J. Hogan & A. Sowden, May 2, 1871, 114,509
Planing, W. S. Winsor, Nov. 5, 1861, 33,673
Reciprocating, C. Germann, Aug. 21, 1870, 29,688
R. H. Osgood, Aug. 23, 1859, 25,214
Mill, S. Taner, Oct. 20, 1857, 18,474
Rotary, R. S. Thomas, July 1, 1836,
Round, Z. Cox, Mar. 14, 1794,
Scroll, J. Atkinson, Nov. 4, 1873, 144,181
J. Atkinson & W.H. Kimball, Sep.17, 1872, 131,323
G. L. Baar, Nov. 19, 1861, 33,732
C. M. Baxter, Sep. 29, 1868, 82,585
H. L. Beach, Dec. 2, 1873, 145,084
A. Beekman, Sep. 8, 1863, 39,790
H. Bickford, Feb. 25, 1873, 136,207
B. J. Camp, Feb. 18, 1868, 74,497
A. D.Campbell, Nov. 21, 1865, 51,105
Saw, Scroll, T. L. Cornell & S. Whitlock, Aug 15, 1871, 117,987
W. H. Doane, Jan. 24, 1865, 45,981
" Jan. 7, 1873, 134,650
" & W.H.Dobson Jan. 21, 1873, 135,099
W. Dobson, Sep. 29, 1863, 82,501
W. H. Dobson, Jan. 31. 1871, 111,328
W. Gardner, Mar. 28, 1871, 113,042
A. Girandat, July 8, 1862, 35,817
T S. Greenman & C. A. Fenner, Feb.13,1872, 123,561
N. B. Hadley, Aug. 9, 1870, 106,153
F. H. Hardenbergh, Jan. 14, 1873, 134,882
S. Harrington, Dec 5, 1865, 51,312
I. Hird, Oct. 3, 1871, 119,517
H. H. Humphrey & H. Bickford, May 23, 71,115,210
R. McChesney Apr. 12, 1870, 101,897
" Nov. 1, 1870, 108,921
L. Miller, Apr. 18, 1871, 113,907
G.M.Nickerson, Mar. 8, 1870, 100,551
M. G. Ogden, July 5, 1870, 105,120
I. R. Ritter, Oct. 24, 1871, 120,326
J. W. Rowlingson, July 22, 1873, 141,080
A.M. Schilling, Nov. 8, 1870, 109,060
H. B. Smith, Apr. 22, 1863, 138,103
W. A. Sweet, Jan. 7, 1862, 34,078
E. A. Walker, May 27, 1873, 139,284
B, D. Wallace, Aug. 29, 1871. 118,498
J. B. Wright, Dec. 30, 1873, 146,118
Whip, S. Barber & N. W. Tompkins, June 1, 1808,
with Detachable Teeth, T. P. Marshall, Mar. 21, 1871, 112,943
Wood, R.& A.F.Andrews, Jan.24, 1854, 10,439
R. Blake, July 26, 1859, 24,903
J. Hamilton, July 31, 1809,
" June 10, 1830,
A. Pruyn, Sep. 11, 1860, 29,991
Stone, G. W. Cherry, Aug. 1, 1854, 11,410
P. Sweeney, Aug. 30, 1859, 25,287
S.Chapman, jr., Nov. 29, 1853, 10,281
& Marb., J. T. Bruen, May 8, 1855, 12,813
W. Watson, Aug. 1, 1854, 11,432
H.H.White& E. A. Gray, Aug. 30, 1859, 25,287
Stone Cutting & Dressing, I. E. Newton, June 8, 1869, 91,155
Endless, G. Kammerl, Dec 1, 1863, 40,757
for cut'g hedge for plashing, D Gore, July 13, 1869, 92,602
for cut'g round t-nons. rot'y, C. Whitsmith, Sep. 25, 1839, 1,337
for cut'g timb. J. Ruthren, Nov. 30, 1835,
for fell'g trees, W. Hunt, Jan. 6, 1836,
S. Warner, Mar. 22, 1864, 42,034
making clapboards, circ., R.Eastman & J.Jaquith, Mar.16, 1820,
making stuff'g for upholst'g, G. W. Marble, July 19, 1870, 105,469
prepar'g blocks for matrices, c. J. Morgan, June 27, 1839, 1,203
sawing and smooth'g b'ds, G.F.Woolston, Sep. 30, 1851, 8,393
saw'g boards or timber, d'ble t. S. Dauley, Jan. 14, 1831,
sawing fellies, G. Steck, June 7, 1870, 104,074
saw'g fret holes in fan sticks, J. W. White, Oct. 3, 1871, 119.678
saw'g mach'y, self-setting, A. Arnold, June 24, 1856, 15,163
sawing stone, A. Eames, July 27, 1852, 9,147
J. E. Emerson, Apr. 25, 1871, 113,993
" June 4, 1872, 127,585
sawing timber annular; R Grant, Oct. 8, 1838, 973
sawing timber, wood, etc.; ch. P.P.Quimby, June 3, 1834,

For saw'g water horiz'tal, or vertical; rad'l,	W. O. Willis,	Sep. 20, 1853,	10,042
	A. Stewart	July 5, 1817,	
Saw,	W. H. Bentley,	Apr. 14, 1874,	149,562
	J. W. Branch,	Mar. 3, 1874,	148,027
	M. Chase,	July 14, 1874,	152,970
	W. Clemson,	Feb. 17, 1874,	147,609
	H. Disston,	May 26, 1874.	151,363
	C. D. Lothrop,	Feb. 10, 1874,	147,335
	W. P. Miller,	May 19, 1874,	151,043
	J. T. Tunis,	June 23, 1874,	152,437
	S H. Vosburgh,	Aug. 11, 1874,	154,104
Circular,	E. Andrews,	Nov. 10, 1874,	156,748
	W. P. Hale,	Apr. 14, 1874,	149 748
	I. Hogeland,	Apr. 21, 1874,	149,932
Diamond,	J. D. Husbands jr.	Jan. 20, 1874,	146,681
	"	June 23, 1874,	152,378
Hand,	G. Abrams,	June 9, 1874,	151,818
	H. Disston,	June 23, 1874,	152,347
	H. Howson,	Oct. 13, 1874,	155,950
Jig,	C. A. Fenner,	Nov. 3, 1874,	156,417
Scroll,	W. H. Dobson,	Feb. 24, 1874,	147,913
	C. T. Ford,	Mar. 17, 1874,	148,684
Stone,	J. T. Husbands jr.	Jan 20, 1874,	146,680
	S. G. Morrison,	Sep. 22, 1874,	155,165
Wabble,	D. F. Smith,	Nov. 10, 1874,	156,823
Wood,	P. Painter,	Mar. 3, 1874,	148,239
	C. A. Brown & C. E. Sedore,	July 6, 1875,	165,152
	W. P. Miller,	Oct. 5, 1875,	168,338
Band,	A. Newhall,	Mar. 23, 1875,	161,263
	G. F. Wood,	Sep. 14, 1875,	167,721
Buhl.	E. Brown,	May 18, 1875,	163,296
Butcher's,	W. Millspaugh,	Nov. 23, 1875,	170,181
Cross-cut,	J. E. Emerson,	Dec. 7, 1875,	170,833
Cylinder,	J. M. Pierce & F. M. Kinsman	Aug. 17. 1875,	166,718
Drag,	H. H. Miller,	July 20, 1875,	165,749
Hand,	H. Disston,	Jan. 19, 1875,	158,921
	"	Sep. 21, 1875,	167,996
Jig,	S. B. Fuller,	July 6, 1875,	165,162
	C. M. Hayden,	Feb. 2, 1875,	159,412
	E. J. Westcott,	Feb. 23, 1875,	160 943
	G. S. Williams,	Mar. 30, 1875,	161,583
Scroll,	J. M. Benger	Feb. 23, 1875,	160,144
	W. H. Briggs,	Nov. 16, 1875,	170 048
Saw,	C. Albertson,	July 4, 1876,	179,390
	E. M. Boynton	Mar. 28, 1876,	175,330
	J. E. Emerson,	Feb. 29, 1876,	174,216
Band,	P. H. Edge,	Jan. 11, 1876,	172,093
Circular,	H. Disston,	Sep. 12, 1876,	182,178
	F. F. Taylor,	Dec. 12, 1876,	185,363
Cotton gin,	C. F Scattergood.	Aug. 8, 1876,	180,793
Hand,	H. Disston & C. T. Shoemaker,	Aug 22, 1876,	181,422
Jig,	E. H. Benedict,	Feb .29, 1876,	174,105
	P. Hughes,	Mar. 21, 1876,	175,101
	W. I Winne,	May 30. 1876,	177,039
Saw, Pile,	D. Bean,	Aug. 1, 1876,	180,523
Scroll,	J. & W. F. Barnes,	Feb. 1, 1876,	172,951
	H. L. Beach,	Oct. 3, 1876,	182,743
	H. J. Cordesman jr.	May 23, '76,	177,621
	P. G. Giroud,	July 18, 1876,	179,907
	E C. Watterman,	Mar. 7, 1876,	174,395
Saw,	W. D. Westman,	June 13, 1876,	178,821
	J. T. James,	Sep. 25, 1877,	195,610
	W. P. Miller,	Sep. 25, 1877,	190,062
	C. J. Wilson,	July 31, 1877,	193,740
	"	Nov. 6, 1877,	196,850
Circular,	H. Disston,	June 19, 1877,	192,240
	D. B. McRae,	Aug. 7, 1877,	193,985
	S. N. Poole, jr.,	June 26, 1877,	192,526
	E. W. Tilton,	May 22, 1877,	191,198
	"	Nov. 27, 1877,	197,688
Hand,	C. Disston,	Jan. 30, 1877,	186,814
	L. Share & S. Y. Reams,	May 15, 1877,	190,914
Jig,	L. T. T. Stanley,	May 22, 1877,	191,189
Planing,	I. S. & C. N. Brown,	Nov 20, 1877,	197,325
Scroll,	J. A. House,	Apr. 10, 1877,	189,461
Shingle,	J. Morreau,	Dec. 11, 1877,	198,142
Tub'l'r Gang,	J. A. Balch,	Jan. 16, 1877,	186,293
Saw,	C. W. Hubbard,	Nov. 12, 1878,	209,810
	R. E. Poindexter,	May 28, 1878,	204,369
Band,	J. Kraus,	July 9, 1878,	205,876
Circular,	J. F. Milligan,	Jan. 29, 1878,	199,851
	"	" "	199,852
	G. F. & D. Simonds & A. A. Marshall,	Aug. 27, '78,	207450
Drag,	W. W. Giles,	Oct. 1, 1878,	208,472
	F. Mayrhofer,	June 25, 1878,	205,197
Hand,	W. Berney,	Aug. 20, 1878,	207,159
	J. R. Woodrough.	Apr. 16, 1878,	202,500
Scroll,	G. W. Griffin,	Dec. 3, 1878,	210,421
Planing,	J. A. Robbins,	Jan. 7, 1879,	211,259
Saw,	J. A. Robbins & J. E. Bumpus,	Jan. 14, 1879,	211,346
Drag,	W. H. Smyth,	Feb. 11, 1879,	212,278
Circular,	G. Schleicher,	Feb. 18, 1879,	212,516
Jig,	G. W. Cary,	" "	212,355
Circular,	J. A. Miller,	Mar. 4, 1879,	212,813
Cotton-gin,	J. E. Carver,	Mar. 11, 1879,	213,169
Circular,	W. P. Miller,	Mar. 18, 1879,	213,439
	W. S. Hill,	Apr. 16, 1879,	214,389
	"	" "	214,390
Fire-w'd Drag,	F. B. Haga & M. W. Henry	May 6, 1879,	215,109
Drag,	W. S Brewer,	June 10, 1879,	216,374
	T. B. Fagan,	June 17, 1879,	216,663
	J. Showalter,	July 8, 1879,	217,416
Circular,	T. Tripp.	"	217,305
	D. W. Weaver,	Sep. 23, 1879,	220,008
Drag,	J. Angspurger & J. Neimeyer,	Oct. 14, 1879,	202,565
Scroll,	C. A. Dearborn,	Oct. 21, 1879,	220,705

The above comprises all SAWS patented in the United States from 1790 to November 15th, 1879.

Compiled by

JOHN A. WIEDERSHEIM,

Solicitor of Patents,

No. 110 S. Fourth St., Philadelphia, Pa.

Through whom copies of specifications, drawings and claims may be ordered and obtained.

ADDENDA.

For soft wood, teeth such as *A*, in the figure, answer well, the cutting edge being perpendicular. For hard and knotty wood, the shape

should be that of *B* (angle of 60°, equally divided front and back). For miscellaneous sawing, sometimes hard, sometimes soft, *C* is the good form; an angle of say only 40°, equally divided front and back.

The American system of cutting to dimension in the forest is a great waste of timber; as one-quarter of the stuff, after squaring, is wasted in kerf, and by irregularities of seasoning, warping and scratching, one-tenth more is lost, making in all three-tenths. When taken to the mill to be planed it is so covered with grit, and sometimes with a "crust" hard to remove, that an English planer is too light to work American stuff. In addition to this, lumber yards have to keep on hand an excessive assortment of various dimensions, which a European yard would saw to order.

CORUNDUM, the hardest of Nature's products, next to the diamond, is sawed into blocks by the use of Tilghman's cast iron shot. (See *Polytechnic Review*, vol iv, p. 149).

Horace Greeley, in his account of a brief tour in Europe taken by him in 1851, speaks of an Italian wood-sawyer, whose performance attracted his particular attention, from the fact that, instead of applying the saw to the wood, he took a stick of wood in his hands and rubbed it on the saw. Mr. Greeley estimated that a sharp American would saw as much in an hour as the Italian laborer in a week.

Strength of Band Saw Blades. From "Polytechnic Review," Phila.

"Test of the strength of eight specimens of Perrin's Band Saw Blades, with brazed joints, by Richards, London & Kelly, made on Riehlé Bros. Testing Machine, July 19, 1876:

No.	Thickness.	Width.	Width nearest $\frac{1}{16}$ inch.	Breaking Weight.	Strength per square inch.
1	·0346	1·05	$\frac{17}{16}$	7000	209,193 lbs.
2	·0353	·62	$\frac{10}{16}$	4000	182,765 "
3	·0365	·745	$\frac{12}{16}$	6000	220,649 "
4	·0337	1·062	$\frac{17}{16}$	3000	83,823* "
5	·0310	·625	$\frac{10}{16}$	2230	115'090† "
6	·0310	·490	$\frac{8}{16}$	2000	131'060† "
7	·0335	·280	$\frac{9}{32}$	2000	213,210 "
8	·0310	·094	$\frac{3}{32}$	485	16,430 "

* Broke at end of joint. † Broke across centre of joint.

"The average strength of the unjoined pieces was 446 lbs. for each $\frac{1}{16}$ inch in width, and the strength of the weakest (which were the narrowest also), 323 lbs.; while the average strength through the joints for each $\frac{1}{16}$ inch in width was 206 lbs. per $\frac{1}{16}$ inch; in the weakest, 176 lbs. All the blades for the ordinary saws are made of No. 19 B. W. G. steel, and vary only by the inequalities caused by grinding or filing the joints. The knowledge that when a band saw is being strained to the amount of 175 lbs. for each $\frac{1}{16}$ inch in width it is strained to nearly its limit of endurance, may be of some value to the makers and users of band saws."—*John E. Sweet.*

Wyman, Buswell & Co., of Grand Haven, Mich., write of a steam feed of 18½ inches per revolution in a 12-inch cut, with a Simonds' "unhammered" saw of 58 inches diameter and 60 teeth, with spring set.

Kellogg, Sawyer & Co, Leroy, Mich., cut 50,000 feet per day with a 72″ solid saw, and have made 85,310 feet of inch lumber in 11 hours.

For "trying the backbone of a saw," Norway pine affords an excellent opportunity.

When circular saws were first made the mandrel hole was square. This was the case as late as 1846 or 1847 with gin-saws.

A HANDY TABLE.—A thousand feet of flooring or ceiling will lay 800 feet of solid superficial measure; 1000 feet of siding, 750 feet; 1000 feet of rustic siding, 10 inches wide, 900 feet.

Nearly $144,000,000 is invested in the United States in the sawn lumber industry alone, that is, in making laths, shingles and boards. Wood forms the fuel of two-thirds of our population, and the partial fuel of of nine-tenths of the remaining third.

All lumber is measured before planing, and is so calculated in all bills.

Average green fir lumber weighs four and a half pounds to the foot; seasoned, four pounds. Green cedar about the same as fir seasoned, three pounds; 500 feet of either green fir or cedar is equal to one ton. Green cedar shingles weigh about 400 pounds to the thousand; dry, 250 to 300.

Shingles baled in what are called half bunches should overrun, or, in other words, contain 504 shingles; quarter bunches fall short four to the bale, or 16 to the 1000.

"By their circular, we see that two Boynton brothers, by hand, cut off a twelve-inch sycamore (buttonwood) log in *eight seconds*, before Major General Meade and other distinguished men, at Independence Square, Philadelphia, September 1, 1869. We also note, as a proof of the ease that permits sustained effort, the sawing, by hand, of twenty-six cords of hard beech, maple, elm, ash and hickory wood in eight hours (ten hours, including lost time) in Grand Rapids, Michigan, Such work, by two men, with one saw once filed, is wonderful."—*Iron Age*, April 7, 1870.

At Philadelphia, July 6, 1876, an ash log, 11 inches in diameter, was sawed off with a 4½-foot two-man Lightning Cross-cut, in six seconds, which would be at the rate of a cord of wood in four minutes if it could be prolonged. June 28th, before Dom Pedro, a 12-inch gum log was sawed in seven seconds.

"As it costs five hundred or more dollars for the labor that wears out the cross-cut saw, a saving of one fifth by speed and ease of an improved saw saves the cost of a dozen."

A SUPPLEMENT TO

GRIMSHAW ON SAWS.

CONTAINING ADDITIONAL PRACTICAL MATTER, MORE ESPECIALLY RELATING TO THE FORMS OF SAW TEETH FOR SPECIAL MATERIAL AND CONDITIONS, AND TO THE BEHAVIOR OF SAWS UNDER PARTICULAR CONDITIONS.

ONE HUNDRED AND TWENTY ILLUSTRATIONS.

BY

ROBERT GRIMSHAW,

AUTHOR OF "MODERN MILLING," "MILLER, MILLWRIGHT, AND MILL FURNISHER," ETC.

PHILADELPHIA:

E. CLAXTON & CO.,

930 MARKET STREET.

LONDON: E. & F. N. SPON, 48 CHARING CROSS.

1882.

COPYRIGHT:
ROBERT GRIMSHAW.
1882.

COLLINS, PRINTER.

PREFACE TO THE SUPPLEMENT.

THE success attending the publication of "Grimshaw on Saws" has led the author to collect such material, referring more strictly to all kinds of saw blades, as has come to his hand since 1880. At all times in active correspondence with practical sawyers throughout the country, many valuable points concerning forms of teeth for special materials and conditions, and many useful hints concerning the care and management of saws, have come to his hand; which, together with descriptions of some of the most important devices patented since publishing the main work, have been incorporated in this supplement, which have been added to the original work so as to constitute a second edition.

Manufacturers who neglected to send in replies to my queries for detailed information concerning their specialties, in time for publication in the first edition, have had afforded them a second opportunity to bring these specialties before the public, and at the same time be sure that the descriptions and illustrations are absolutely correct.

To obviate unnecessary repetition, data which might probably appear under two heads have been placed, as far as possible, where the relationship is the strongest.

The index is full and complete, and the reader is advised to consult it carefully when searching for information.

The table of saw patents compiled by Mr. Wiedersheim for the original work, is supplemented by lists up to April, 1882.

The list of errata reported in the original work is larger than the author would prefer—but still it is better to give it than to allow the misprints, etc., to remain uncorrected.

The "*Cincinnati Artisan*" and the Buffalo "*Lumber World*" have kindly permitted the use of engravings, and of matter written by the author, which have appeared in those periodicals.

PHILADELPHIA, June, 1882.

SUPPLEMENT.

SPECIAL MATERIALS AND TEETH THEREFOR.

Choice of Teeth for Various Woods.—The kind of teeth and the speed of the saw should be determined by the hardness and grain of the material, its greater or less freedom from moisture, from gummy or resinous matters, and from spikes; whether frozen or not; also its size. The harder the wood the smaller and more upright should be the teeth, and the less their velocity and the rate of sawing. *Pine*, *willow*, and *alder* require large, acute, and well-pitched teeth. *Oak*, *mahogany*, and *rosewood* need perpendicular teeth, close together. *Yellow* and *pitch pines* and *larch*, being gummy and resinous, require grease to clear the blade. *California redwood* cuts like Eastern pine. Fig. 235 shows the

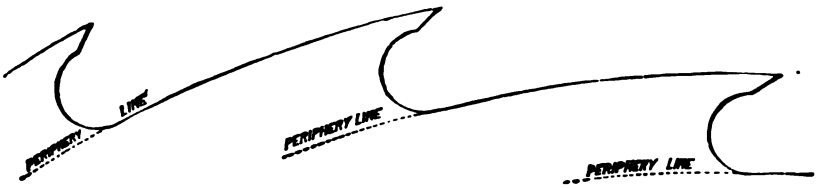


Fig. 235. For Soft Wood.

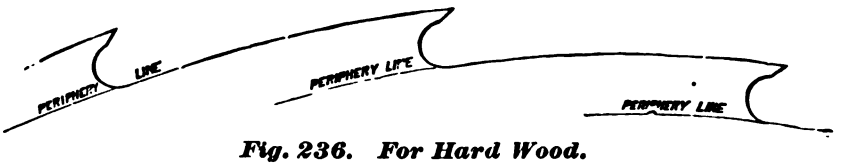


Fig. 236. For Hard Wood.

teeth for soft wood, Fig. 236 those for hard. We may say that for *pine*, *spruce*, and *hemlock*, the teeth should be cut tangent to a circle half the saw's diameter.

Cedar cuts best with a peg tooth, of fine gauge, pitch, and space. *Mahogany*, *ash*, and *English elm* are best cut with the gullet or mill tooth, of small space and nearly upright pitch.

For *maple*, *oak*, and all timber known as *hard wood*, teeth that are only swaged answer (Fig. 237). For *hard wood in warm weather*, *Norway pine* and *chestnut*, teeth part bent and part upset (Fig. 239)

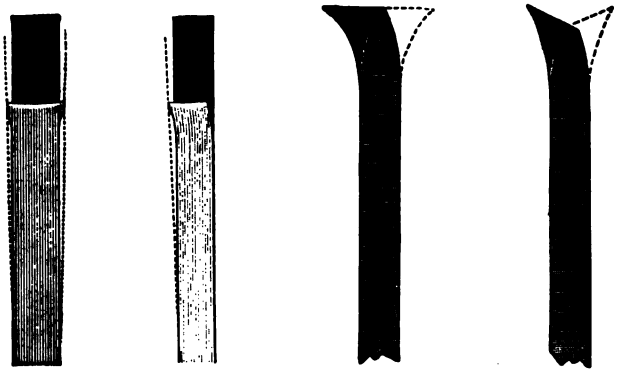


Fig. 237. ***Fig. 238.*** ***Fig. 239.*** ***Fig. 240.***

answer. For *water-soaked spruce* and *pine*, teeth bent only (Fig. 238). For *sapling pine in warm weather*, teeth bent for set, and sheared to an angle of 25° (Fig. 240). *Sapling pine in cold weather* and *second growth chestnut*, upset both sides alike (Fig. 237).

For *yellow pine*, a 56-inch circular, 6 or 7 gauge, with 32 to 36 teeth, has 3½ to 4 inches feed, and runs 650 to 700 revolutions per minute, say 9250 to 10,000 lineal feet of rim speed. In *white pine*, Michigan sawyers use a 66 to 72-inch circular, 5 and 7 gauges, having say 50 teeth to a 66-inch saw; feed 7 to 8 inches per revolution; speed 700 to 800 revolutions per minute, or say 13,000 lineal feet of rim speed per minute; kerf $\frac{5}{16}$ inch.

Inserted Teeth for Hard Woods* should be shorter than those for soft.

Teeth for Warm and for Cold Weather.—In the New England States, where the extremes of temperature are great, it is necessary to provide for the greater brittleness of the teeth and

* "Inserted teeth" are also called "movable," "removable," "insertable," "detachable," etc.

the greater hardness of the logs, in cold than in warm weather. Reference to Fig. 241 will show the comparative pitch of teeth

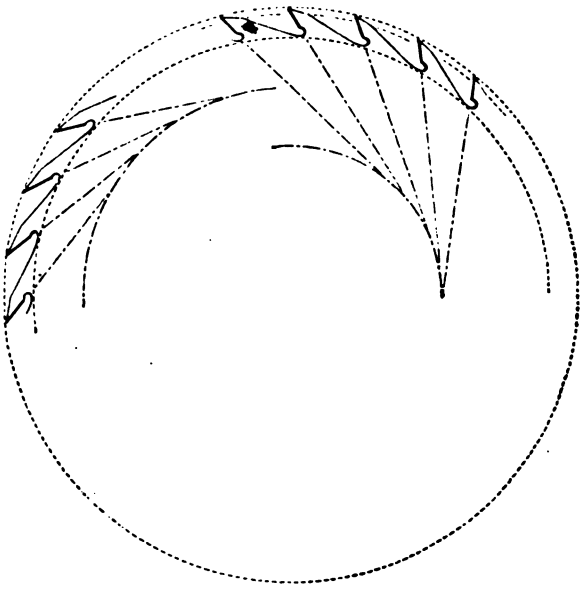


Fig. 241. Pitches for Cold and Warm Weathers.

for cold and for warm weather. The more severe the winter the stouter the teeth need be. In Fig. 241 the teeth for cold weather are $\frac{1}{2}$ pitch, those for warm being $\frac{2}{3}$.

Curious Teeth.—Fig. 242 shows a number of European special forms of teeth, selected by reason of our inability to conceive why such forms should be used. We feel little risk in predicting that they will not be widely copied by American makers.

Circular Saws for Iron. — Disston's remarks, page 45, should read: "A 44-inch saw $\frac{1}{4}$ inch thick, with peg teeth $\frac{1}{4}$ inch space is best for cutting off hot or cold iron. A high rate of speed should be used, say fifteen thousand feet rim motion per minute. These saws are made of very mild steel, not hardened or tempered. For clean cutting in cold metal highly tempered saws are used with front or cutting edge of teeth on a line with the centre, and the number of teeth corresponding, somewhat, to the amount of work to be fed on the saw at each revolution.

Such saws are run at a low speed for steel and wrought iron, say 130 to 150 feet per minute, rim motion, and should be run in a solution of soap, oil, and water. For softer metal a higher rate

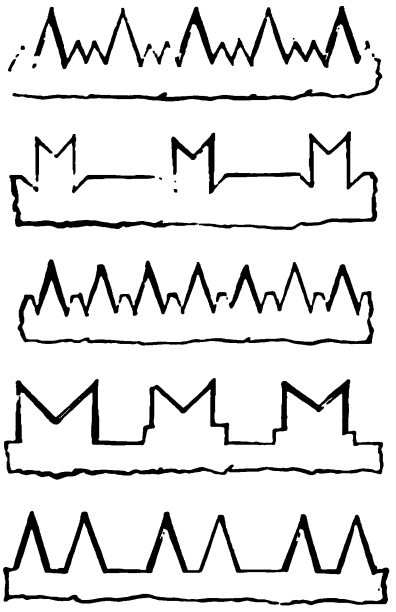


Fig. 242. Odd Forms of Teeth.

of speed is required. A large proportion of iron cutting is done by friction discs, running at a very high rate of speed, say up to 20,000 feet per minute, rim motion."

Cordesman, Egan & Co. would saw cast-iron with V-shaped teeth, "$\frac{1}{32}$ inch full," in height, 12 points to the inch, little or no set; plate 22 gauge.

For tarboard, Cordesman, Egan & Co. recommend the hand rip saw outline of teeth, $\frac{1}{16}$ inch high, 7 points per inch, plenty of set; plate 18 gauge. They say that they cut with such teeth a great deal of tarboard to make friction wheels, and get good results.

FILING.

Angles of Teeth.—Figs. 243 and 244* show the difference in the way of presenting an edge tool of a given angle to the wood.

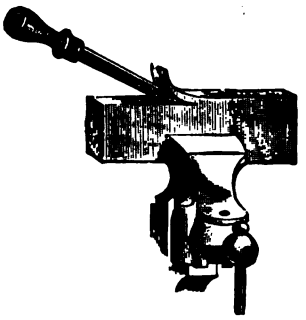


Fig. 243. Held at an Acute Angle.

Fig. 244. Held at a less Acute Angle.

Fig. 245 shows about how deep the file should fill the tooth notches.

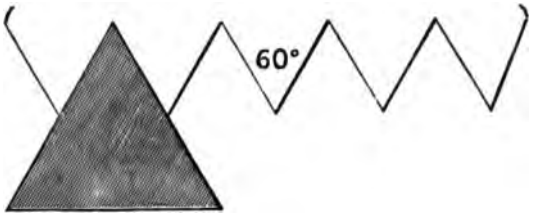


Fig. 245. Depths of Hand Crosscut Teeth.

In Fig. 246 the teeth are about the same height as in Fig. 245; but while the fronts do not reach the middle of the file section, the backs pass it, about averaging the wear.

Figs. 247 and 248 are of those shapes impossible to sharpen without a file of special section.

---

* By courtesy of Frey, Schechler, and Hoover.

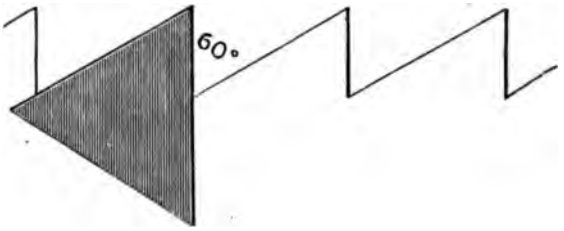


Fig. 246. Depth of Rip Saw Teeth.

Fig. 247. Acute Angled Teeth.

The "peg" tooth (Fig. 249) permits the use of the ordinary rectangular "mill" file; but the file shown is not wide enough for the teeth to which it is applied.

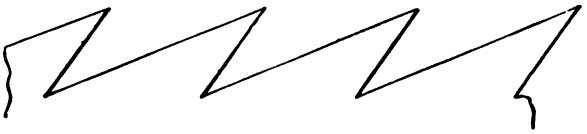


Fig. 248. Great Rake.

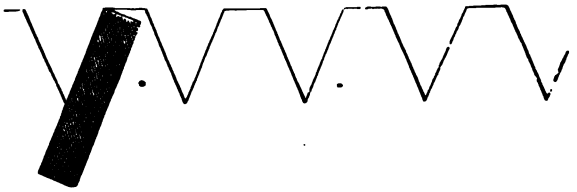


Fig. 249. Flat File on Peg Teeth.

To file "briar" and "half moon" teeth of the outlines shown in Figs. 250 and 251, it is best to have a sheet iron or zinc template to compare with.

Briar

Fig. 250.

Such M teeth as Fig. 252 (Holzapffel, 1846) would be extremely difficult to sharpen, and more liable to break than our stronger and more graceful forms, as shown by Fig. 253.

Fig. 251.

Fig. 252. M teeth of 1846.

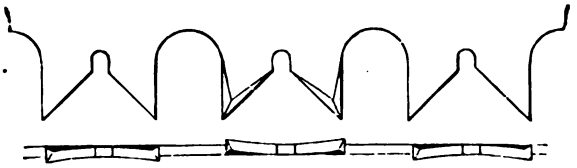


Fig. 253. Modern M teeth.

The same may be said in reference to the square-throated circular saw teeth seen in Fig. 254.

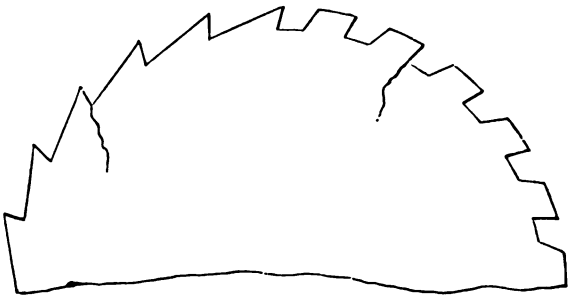


Fig. 254. Square Throat.

As the fibres of a slab or plank run, as shown in Fig. 255, it will be seen from Fig. 256 that ripping teeth cut each fibre only once, while in crossing (Fig. 257) each fibre is severed twice.

Fig. 255. Fibres of a Slab.

Fig. 256. Action in Ripping.

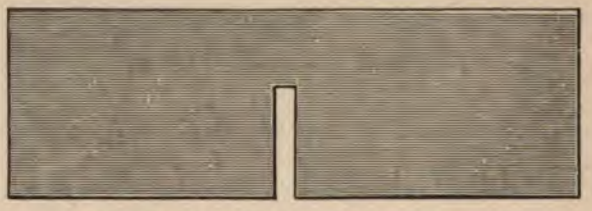


Fig. 257. Action in Crosscutting.

Cleaner Teeth.—Grandy says that cleaner teeth in crosscuts should point towards the drag or draw.

Round Gullets.—It is very desirable that the gullets be round. Grandy, in recommending round gullets for all saws, says: "I have seen a 50-inch board saw run on a cast-iron dog $1\frac{1}{2} \times 2\frac{1}{4}$ inches, breaking or cutting the dog in two, and turning some of the teeth to a right angle with the plate. I have bent them back without breaking a single tooth. This was simply because the gullet was round. The same saw had one of its teeth broken while in the cut previous to this, while the throat was square-cornered."

The Gridley Tooth.—Fig. 258 shows the ordinary spring set; Fig. 259 the spread set proper; Fig. 260 the Gridley circular saw

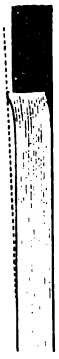


Fig. 258.
Spring Set.

Fig. 259.
Spread Set.

Fig. 260.
Gridley.

tooth referred to on page 60, and combining both spring and spread set. The dotted lines show the clearance.

Sheared Teeth.—"A tooth sheared or filed to a bevel of say 5° to 20° will do the work with less power (provided the tooth is strong enough otherwise to resist the tendency to spread in the cut). If a person were to take a jack-knife to cut a stick of any size, he would turn his knife to about that angle with the grain. The sheared tooth is in better shape to enter the wood than if swaged square; whereas it is often nearly impossible to saw sapling pine (such as grows in Massachusetts and Connecticut) in summer time with swaged teeth, if the teeth are bent and sheared the trouble disappears entirely. Another objection to swaged teeth is the excessive wear of the plate. But shearing must be modified to suit the kind and conditions of the timber. For instance, a spruce log will cut much easier when thawed out than when frozen; so the teeth can be sheared much more in warm weather than in cold. A 7 or 8 gauge saw will have teeth strong enough to resist the tendency to spread sidewise (or make set, as it is termed) in summer in almost any kind of wood. Then, again, logs are apt to have dirt, gravel, and sand in summer time (especially in Massachusetts and Connecticut, and on portable-mill jobs), whereas in winter time they are taken from the stump to saw pretty much free from dirt. This dirt will soon wear off

the swaged set, whereas, if bent, the teeth will do much more work without filing, of course using the swage to keep the point as wide as the plate is thick. This method is almost universal in Vermont, to swage the point ½ set, bend the rest and shear 5° to 10°. In winter the sawyer will bring his saw nearly square, but still bend part and swage the rest."

Shape of File Tangs.—Files having square-shouldered tangs, shown in Fig. 261, are apt to crack in the shoulder in hardening,

Fig. 261. Wrong.

and to break in using. The tang should have a curved shoulder, as in Fig. 262.

Fig. 262. Right.

Round files, instead of being drawn down as shown in Fig. 263, should be given a more parallel tang, as shown in Fig. 264, in which case they will be less liable to come out of the handles.

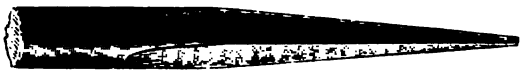


Fig. 263. Wrong.

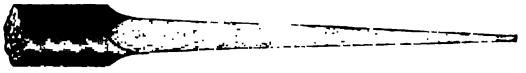


Fig. 264. Right.

The Wentworth Saw Vise.*—The terrible "screeching" so frequently heard in saw filing is obviated by the convenient device illustrated in Fig. 265. There is a flexible rubber cushion

* Made by Seneca Manufacturing Co., Seneca Falls, N. Y.

or muffler between the jaws, preventing any vibration. The jaws are clamped by the cam-plate and lever shown below.

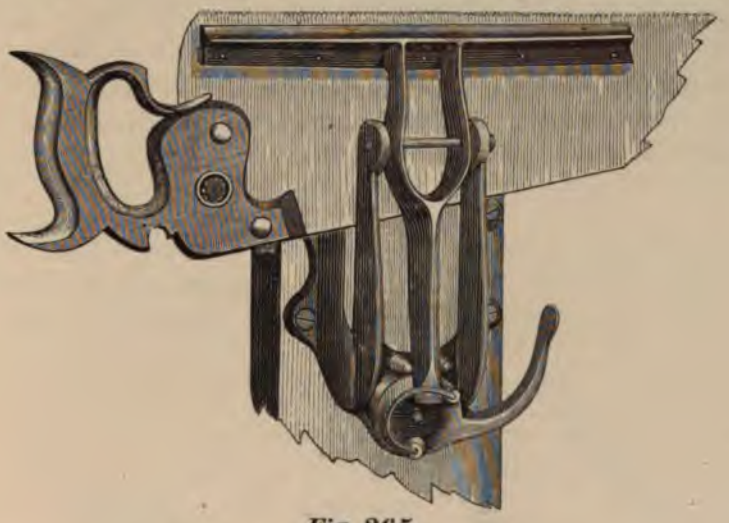


Fig. 265.

Former for Circular Saw Teeth.*—Cut a sheet zinc or other thin metal template, and fasten to the end of a wooden strip which saddles the arbor (see Fig. 266). The backs of the teeth should

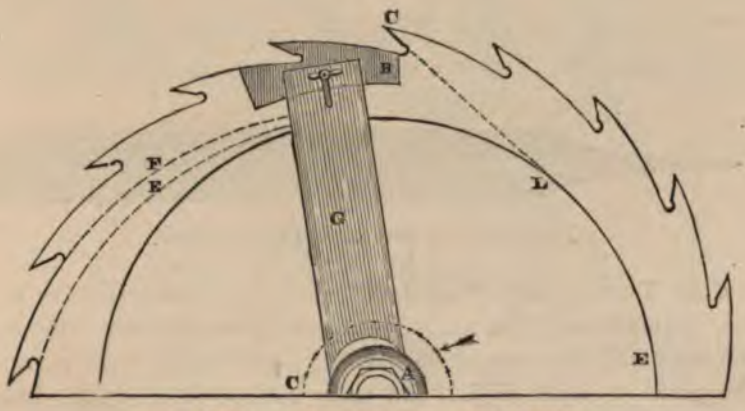


Fig. 266. Forming Circular Teeth.

* Communicated by Frey, Scheckler, and Hoover, Bucyrus.

be circular and struck from centres on the small circle C. The faces are tangent to the large circle shown.

This rule for tooth forming is simple, and the method of applying it equally so.

Parker's Vise for Circular Saws (U. S. Patent, Nos. 236, 451. January 11, 1881,) has a fixed saw and a movable saw vertically adjustable by a slot. Fig. 267.

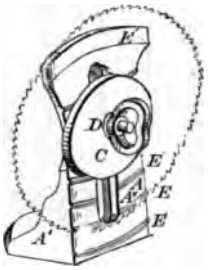


Fig. 267.

SETTING.

The Boynton combined file and set (referred to on page 126) is shown in Fig. 268, and is a very simple and handy instrument.

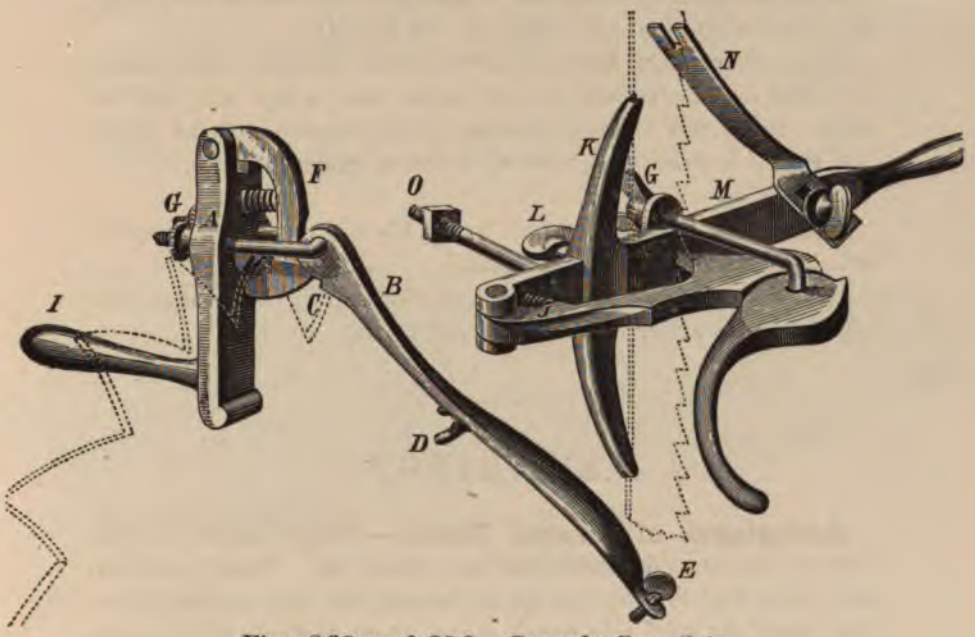
Fig. 268. Combined File and Set.

Cam Power Sets.*—Fig. 269 shows a circular saw in position with the set applied. The operator stands behind the saw, the set being attached to the teeth by placing the bed die, A, on the point of tooth, so that the point will project beyond the die one-sixteenth of an inch. The cam lever, B, is then brought down

* Made by C. E. Grandy, South Barton, Orleans Co., Vt.

to the stop, C, on the cam, bending the tooth toward the latter. A four point gauge is provided on the lever, seen at D, and E is a screw to adjust the same to the amount of set desired. The die bar, F, is governed by the thumb nuts, G, on the cam links projecting through the bed. The advantage claimed for this arrangement is that the bending power is brought to bear on the tooth between the two bed bearings, so that the operator has only to bear down on the cam lever; and the more power he applies, the tighter he fastens the set to the saw. A handle is provided at I for convenience in handling.

For band or jig saws, the form of the set, as represented in Fig. 270, is changed, having a longer bed, terminating in a handle having an adjustable cam link which can be moved laterally on



Figs. 269 and 270. Grandy Cam Sets.

the beds. The die bar is the same as the circular saw set, also the cam lever, having a stop. These, together with the thumb nuts, regulate the amount of set to be given to the saw. The die bar is kept in contact with the cam by the recoil of the spring, J. Sliding laterally upon the bed is a guide bar, K, having a narrow

hanging lip and grooves, and fastened in place by the thumb screw, L. The saw is placed on the set so as to leave the tooth to be set over the bed die, M. The sliding guide bar is then brought up to the back of the saw, and fastened by the thumb screw. The cam is brought down to the stop, giving as much set as desired by screwing up the thumb nut, G. A loose adjustable pawl, N, is hanged to the bed, and is used on very fine saws, to regulate the position of the teeth over the die, M, by engaging the pawl with the teeth; and as the saw is moved the pawl clicks on the teeth, every two clicks indicating the tooth to be set. The advantage of the pawl, in setting very fine saws, is that it saves the close scrutiny otherwise needed; and if the operator stops a moment, it is claimed, it shows with absolute certainty where to commence again. The set can be used with the saw on the pulley, or it can be attached to a bench by the bolt, O.

The maker claims less liability to break the saw teeth because the bend is a curve and not an angle; that a saw will hold set longer when this is used, because of the shortness of the bend; and that it is readily adjusted to different gauges of saws.

In winter the sawyer will bring his saw nearly square, but still bend part and swage the rest.

[A number of automatic machines for setting band saw teeth will be found under the head of band saws.]

SWAGING.*

Advantages of Swaged Teeth. — Swaged teeth do not "dodge" knots as do those that are spring set. Upset teeth also bear more feed than spring set do, because the cross-grained fibres that make the kerf side rough cannot touch the side of the teeth to drive them out of line.

Objections to Swaged Teeth. — An objection to swaged teeth is that they take one-fourth more power to drive than bent

* Swaging is also written "swedging," and also called "jumping," "upsetting," and "spreading."

ones in the same plate; for it is easier to split out the difference in kerf than to cut it out. In other words, it is cutting the sawdust nearly one-fourth finer with swaged than with bent set.

Again, the swaged tooth leaves a ridge (especially in summer) on the log or board behind each swaged corner, something like half the amount of swaging, and this necessitates more set in order to clear the plate.

Sharpening with the Swage.—Some wrongly suppose that a dull saw can be sharpened with the swage. This is not the case, as the tooth becomes obtuse or "stunted," and the surplus metal must be cut away by a file. It would also make the tooth so brittle that the corners would break or "crumble," as termed by sawyers.

The "Planer Bit" Teeth (Fig. 115), p. 71, are swaged at the point.

Swage for Circulars.—Fig. 271 shows a useful swage for circular saw teeth. There is a central handle or shank with pro-

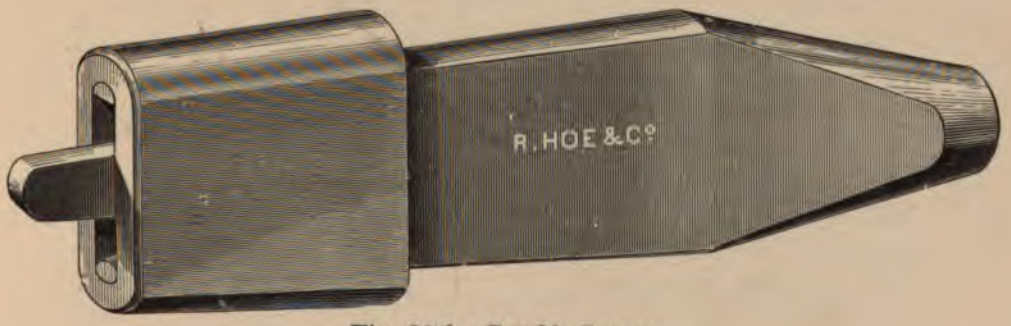


Fig. 271. Double Swage.

jecting tongue and a collar. In the upper space between the tongue and the collar, the tooth is swaged with a flat edge; while in the bottom one the operation is continued so as to give the cutting-edge a concave form.

Simonds' Saw Swage (U. S. Patent, No. 238,062. Feb. 22, 1881,) has a central tooth *a* provided with a double curve upon each of its operating faces; one curve horizontal and the

other curve vertical or longitudinal. One face has longer curves than the other. In swaging teeth with this tool, the longitudinal

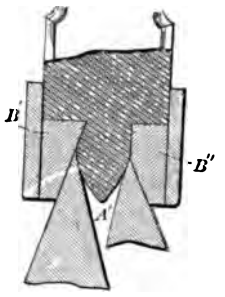


Fig. 272. Simonds' Swage.

centre of the tooth is first indented back from the edge, the tooth next spread by successive blows to right and left of the centre, and then finished or dressed up.

GUMMING.

Gumming by the Sawyers.—The stamp and die are very apt to spring the blade and are practicable only by saw makers.

A grindstone two feet in diameter, bevelled to the desired form, is good to start with.

It may be run with an eight-inch belt, two hundred turns per minute, with a half inch stream of water discharged directly into the cut. This will cut one inch and a half deep in one minute without injury to the saw.

Sharpening Gumming Cutters.—Fig. 273 shows the method of grinding gummer cutters on a grindstone or emery wheel. The

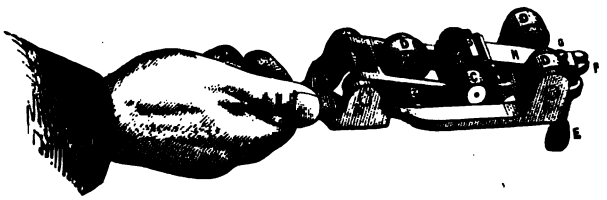


Fig. 273. Holder for Sharpening Gumming Cutters.

frame for holding the cutters is shown reversed. The rollers D, D, run on the face of the stone; the cutter C is ground one face at a time, the pawl H holding each face in position. The gauge E regulates the depth of grinding, and allows for cutters of various diameters.

Gumming Punches.—Fig. 274 shows the shape of punches for gumming gang and mulay saws, and Fig. 275 that for circulars.*

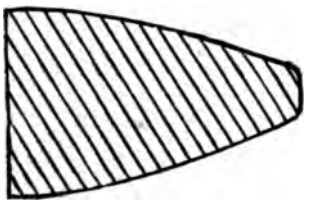


Fig. 274. Gumming Punch for Gangs and Mulays.

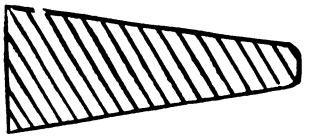


Fig. 275. Gumming Punch for Circulars.

The "Spiral Line" Method of Gulleting (see pages 132 and 137) is a misnomer. There is no spiral line at all marked on the saw—merely arcs of circles having a diameter less than that of the saw-plate.

Frey's Gummer.—Fig. 276 illustrates an emery wheel gummer and grinder, as arranged for grinding or gumming the saw without removing it from its mandrel.

This device consists in an abrading wheel of emery or corundum, fixed on a shaft, set in a flexible frame and put in rapid motion.

By means of a handle it is easily controlled by the operator, and placed at any angle necessary to the saw or article to be filed or dressed.

* Snyder Bros., Williamsport, Pa.

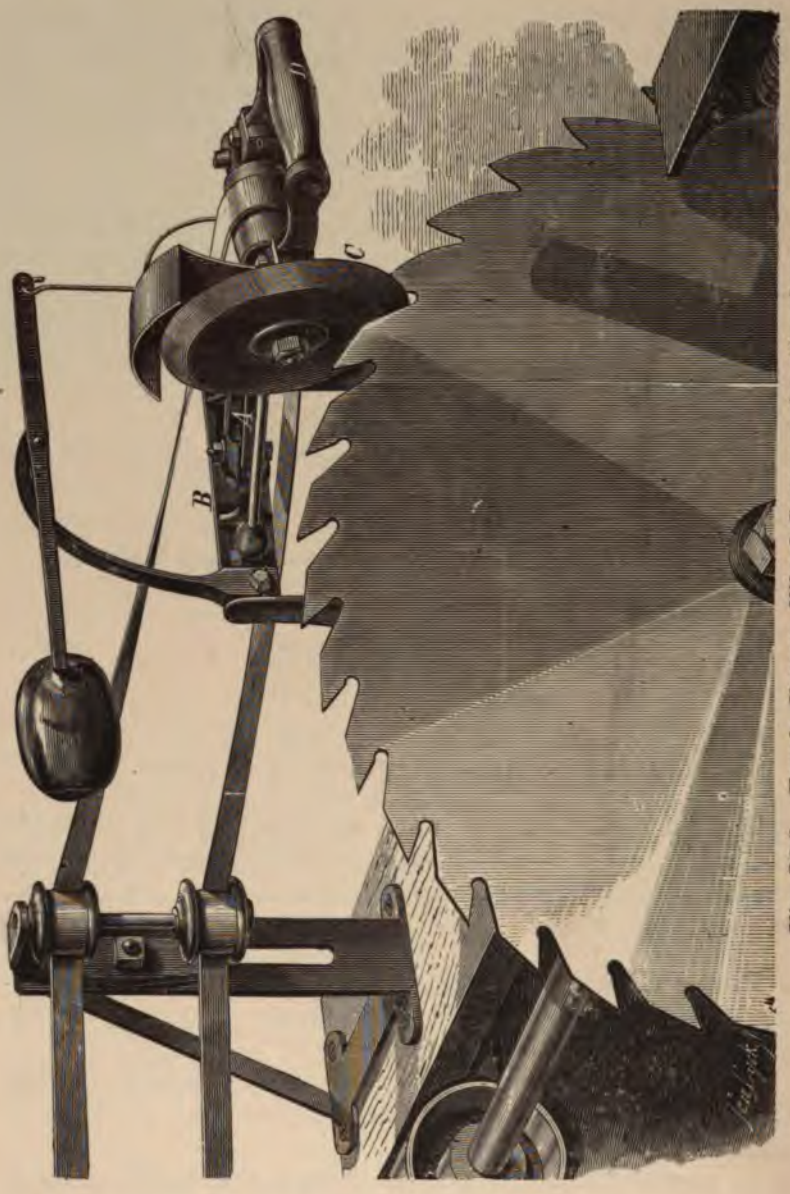


Fig. 276. Frey's Emery Wheel Gummer for Circulars.

It is especially applicable to the gumming of saws, circular or upright, and the shaping or forming of moulding bits, or similar tools.

The working portions of the machine are composed of a movable frame, A, which by a ball joint is hung on the main frame, B, so that the grinding wheel, C, has a universal movement, controllable by the handle, D. A still freer motion is afforded by a second joint on frame A, or the latter may be arranged by means of two movable slides so as to give a positive up-and-down or diagonal movement, as desired, also by two parallel rods hinged on main frame, B, by ball joints, placed on each side of flexible frame, A, and coupled to it immediately back of pulley. By this arrangement a direct parallel lateral movement is secured, and the wheel kept square to its work.

The lever and weight shown, serve to balance the frame and wheel, and make it easy for the operator to control the angle or position of the wheel.

Directions for Setting and Operating.—For a saw-mill run by a belt: Place the machine immediately behind the saw, upon a plank on the side where the teeth turn up, the shaft of the machine being directly over the saw in a line so that the emery wheel will form a right angle with it. The counter-shaft is placed on the back end of the plank, in a direct line with the driving pulley on the engine. The belt or cord is placed upon the small pulley of the machine, then around the small pulleys on the counter-shaft, turning at a right angle to the driving pulley.

The motion of the wheel should be 1500 to 2000 revolutions per minute, the lower side always turning from the operator.

The operator applies the wheel to the saw by means of the handle, when the parts so brought in contact with the emery wheel will be speedily abraded without injury to the saw.

When gumming saws, where the teeth are very blunt, do not attempt to do too much at once, but move from tooth to tooth, giving them time to cool, and then repeat the operation until the tooth is brought to the proper shape.

If the wheel is held to the saw too hard and too long, the saw is liable to blue and case-harden.

To use the machine on a direct acting-mill: The saw is generally taken off. The machine is placed on a frame or table, in such a position that it can be run from the engine or some other convenient shaft.

Mulay, drag, and crosscut saws can be dressed with equal facility.

If it is preferred to dress a circular saw on a direct acting-mill, without taking it off the mandrel, a wheel with a crank is used to rotate the emery wheel by hand. The power required would be about the same as would run a common-sized grindstone.

Shop Machine in Working Position for Dressing Mulay, Circular, or other Saws.—Fig. 277 represents the machine as

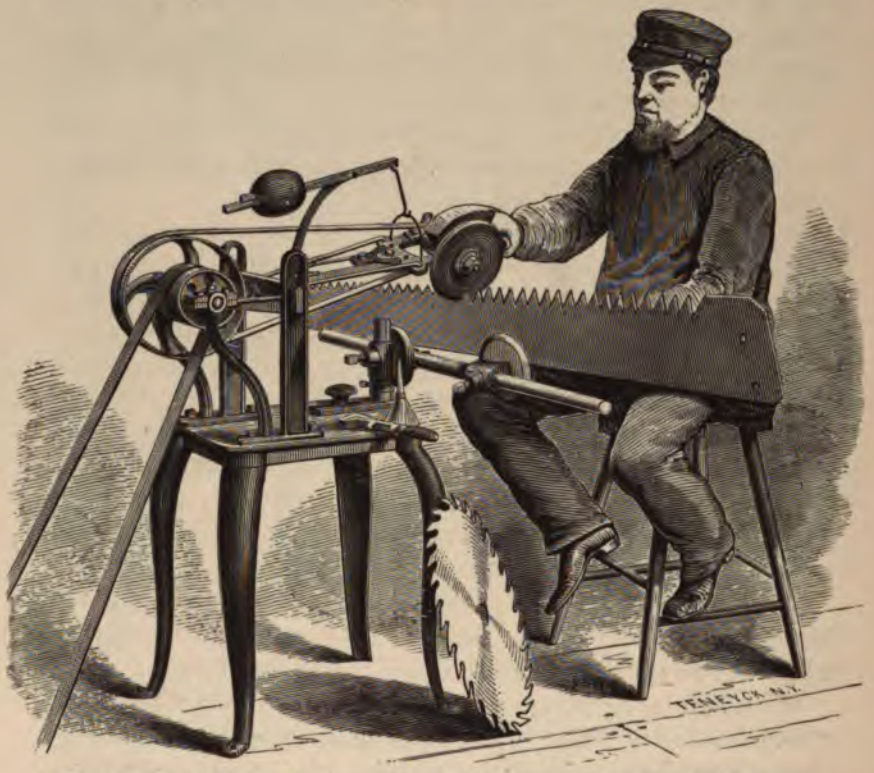


Fig. 277. Frey's Gummer and Sharpener for Straight Saws.

applied to the dressing of mulay, drag, crosscut and circular saws, when removed from their mandrels.

An iron table supports the machine, on which a horizontal counter-shaft is attached, having a tight and a loose pulley, by which it can be run from any desired point, and readily started or stopped by the operator without changing his position. The table also supports the saw-holder device, as shown in the engraving.

Experience in the use of these machines has proved that it is preferable to remove the saw and place it on the machine classed "motive" or shop gummers by the manufacturers.

The universal saw-holder needs some explanation. Fig. 277 represents a drag-saw blade being ground and held between two disks on the holder, in a horizontal position. The arm which supports the disks is adjustable in all directions. For a large circular saw it is depressed and extended to the left of the operator. A conical washer which fits all sizes of holes in the saws, fastens the saw by means of a hand nut.

Frey, Scheckler & Hoover, Bucyrus, O., are the manufacturers of these machines.

Snyder's Gumming Press for Heavy Saws.—In Fig. 278 the lever A, on shaft C, bears an eccentric B, with strap D, giving

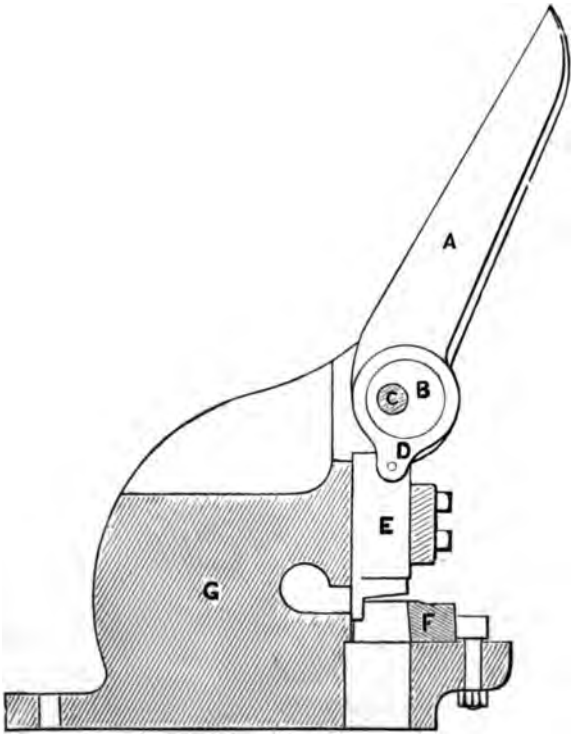


Fig. 278. Section of Snyder's Gumming Press.

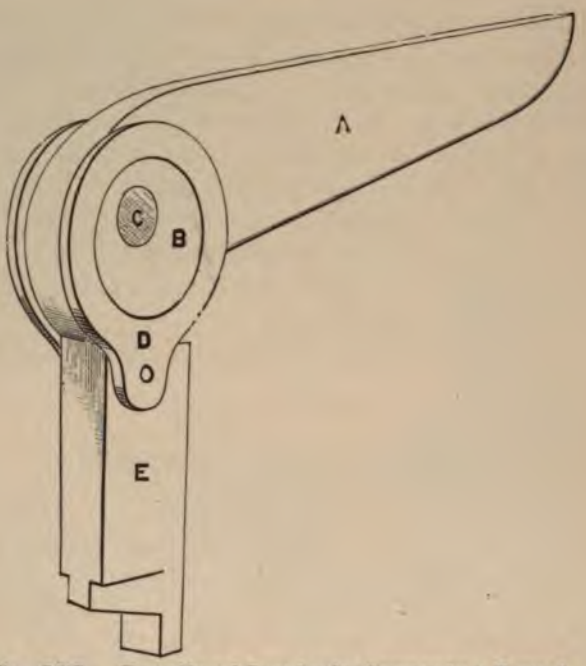


Fig. 279. Details of Snyder's Gumming Punch.

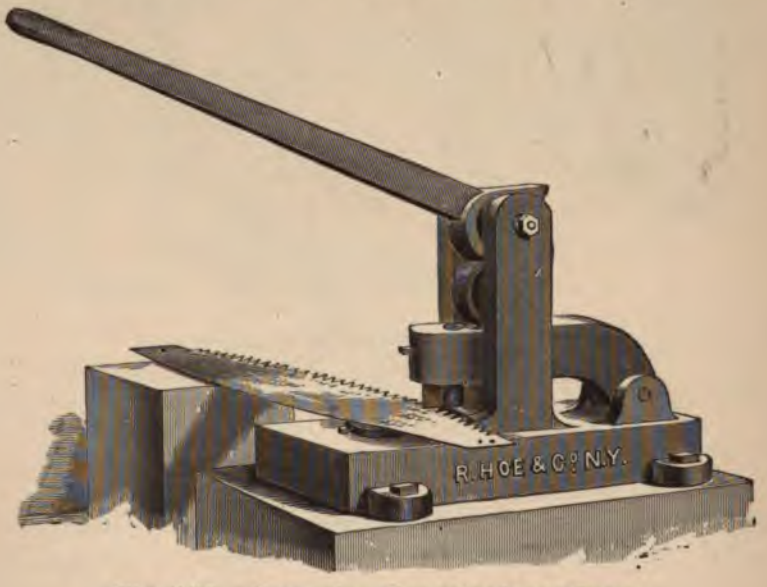


Fig. 280. Gumming Press for large Saws.

motion to the punch E. The die F is suitably adjustable with reference to the frame G. Fig. 279 shows the lever, eccentric, strap, and punch in perspective and rather more in detail.

A Gumming Press for Large Saws is shown in Fig. 280.

EMERY WHEELS.

An Emery Grinding Machine for the chisel bits of the Hoe inserted tooth circular is shown in Fig. 281. The bit is gripped

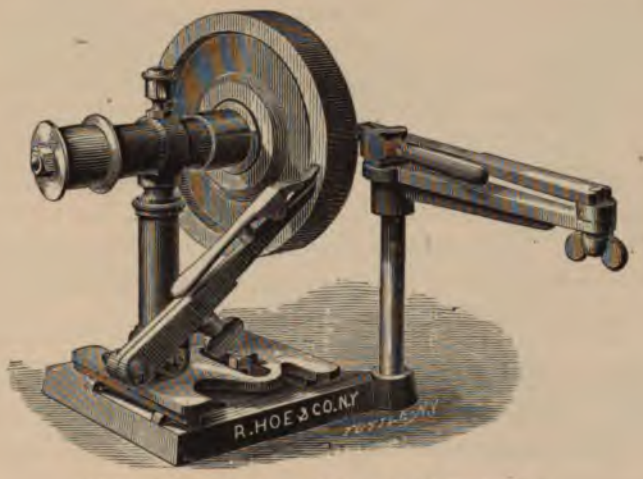


Fig. 281. Emery Wheel Bit Grinder.

by special pincers, and all are held and ground exactly alike on face, side, and back—that is all faces alike, all sides alike, and all backs alike.

The Vulcanite Emery Wheel with Solid Centre is seen in elevation and in section in Fig. 282.

The emery wheel does not stretch a saw on the edge, nor crook it as the press gummer often does. An emery wheel 12 inches in diameter should last to saw from two to four million feet of

lumber. It should be run about 1800 revolutions, or 5000 to 5500 feet per minute.

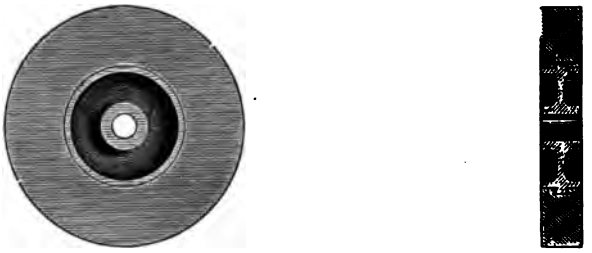


Fig. 282. Vulcanite Emery Wheel.

One emery wheel manufacturer who heads his advertisement, "Why not run your files by steam power?" aptly alludes to the emery wheel as "a rotary file that never gets dull and that runs a mile a minute."

An essential feature in the use of abrading wheels, is to touch the saw lightly and move from place to place in order to avoid heating the tooth. It is a singular fact that when the surface of a steel plate is heated by the friction of an abrading wheel, until it becomes blue, it is made hard to such an extent as to resist the best files. The hardness extends only to a very limited portion of the surface, and is easily removed by retouching it with the wheel lightly.

To Prevent Case Hardening keep the wheel moving back and forth. However, hardening a saw plate by the heat of emery wheel sharpening makes the tooth last longer, if the hardening be not excessive.

Speeds of Emery Wheels.—The following table gives the proper number of revolutions per minute for vulcanite emery wheels of different diameters:—*

Diameter.	Rev. per Min.	Diameter.	Rev. per Min.
1½ inches	10,000	3 inches	4,800
2 "	7,000	3½ "	4,100
2½ "	6,000	4 "	3,600

* N. Y. Belting and Packing Co.

Diameter.	Rev. per Min.	Diameter.	Rev. per Min.
4½ inches . .	3,400	11 inches . .	1,200
5 " . .	3,000	12 " . .	1,000
6 " . .	2,400	14 " . .	950
7 " . .	2,100	15 " . .	900
8 " . .	1,800	16 " . .	850
9 " . .	1,600	18 " . .	800
10 " . .	1,500	20 " . .	700

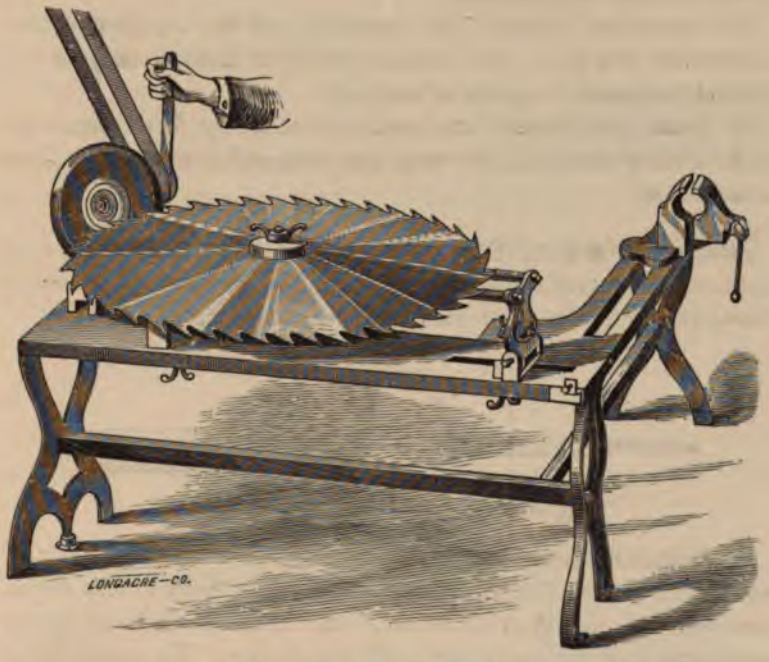


Fig. 283. Andrews' Emery Gummer.

SURGICAL SAWS.

There are few industries which evince yearly more advancement or offer more new mechanical devices, with special adaptations, than does the manufacture of surgical instruments.

Specialists, performing special operations, constantly feel the want of instruments which shall perform, in the most satisfactory manner, delicate operations.

The consumer becomes the inventor, and the number of new instruments put upon the market yearly is limited only by the advance in special branches of surgery.

As these instruments are used where delay from breakage would often prove fatal, the very best material is chosen for their manufacture.

Goodwillie's Oral Saw.—Fig. 284 is a special saw for operations in the mouth, the bend of the bow permitting freedom of action, but stiff enough to prevent the saw from springing.

Fig. 284. Goodwillie's Oral Saw.

Amputating Saws.—Figs. 285 and 286 are different forms of amputating saws. The teeth of these saws cut only on the downward stroke, and are without any set. Where used for heavy operations, they are made very stiff and strong. The smaller saw is used in lighter operations and in positions where the larger instrument would be impracticable.

Fig. 285. Pfarre's Amputating Saw.

Fig. 286. Light Amputating Saw.

Szymanowski's Bone Exsecting Saw.—Fig. 287 shows bone exsecting saw, improved by Tiemann & Co. The novel fea-

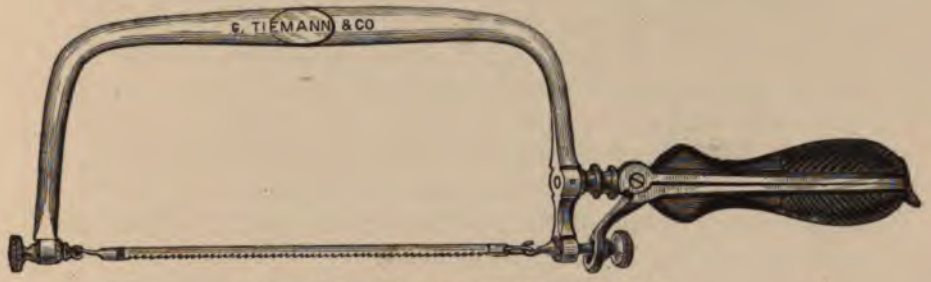


Fig. 287. Szymanowski's Exsector.

ture of this saw is that the blade can be rotated by means of the wheel below the handle. This saw has special advantages in some operations.

Bone Saws for Operations of the Skull.—Fig. 288 represents a bow saw, with two blades, for capital operations. By

Fig. 288. Bow Saw with two blades, for Capital Operations.

means of the screw beneath the handle the blade may be strained to any degree of tightness.

ONE-HAND SAWS.

Superiority of American Saws.—I never saw any but an American hand-saw that could be bent into a hoop, point to heel, and which would then spring back straight and true, like the old-time (Toledo) sword blades. And one of our factories submits all of its first-class hand-saws to this test before sending them out. I never heard of any but an American crosscut by which two men have cut off a sound 12″ gum log in *seven* seconds by the watch. To be sure, there was a real live emperor looking on, but all the sawyers from France to Fond-du-Lac could not have performed that feat with any but an American saw.

The Steel Bucksaw Frame, p. 50, is claimed never to warp nor lose its elasticity, to be unaffected by weather, stand more rough usage than a wood frame, and be less trouble. If I could set an M tooth buck-saw blade in one of these all steel self-strained spring frames, I would not trade that combination for a dozen such affairs as saw makers are obliged to make for country store-keepers to hang up on sale.

A Detachable Bladed Compass Saw,* shown in Fig. 289, takes up very little room, when taken apart; and blades of any desired coarseness of teeth may be used. It will be noticed that

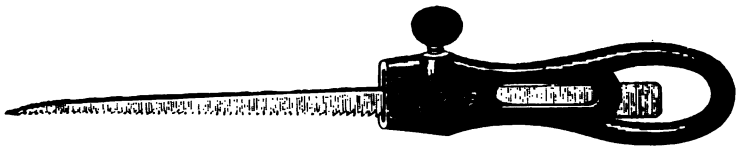


Fig. 289. McNiece's Detachable Compass Saw.

the binding screw grips the back of the blade instead of the side, as is usually the case with such tools. Mr. McNiece will furnish blades for this saw with teeth pointing towards the butt,

* Made by Wm. McNiece, 525 Cherry Street, Philadelphia.

so as to have the desirable "pull cut" recommended on page 17 (see Figs. 10 and 11).

An Egyptian Pull Cut Saw is shown in Fig. 290.

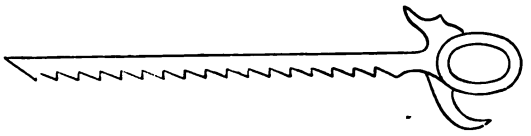


Fig. 290. Ancient Egyptian Saw.

Pruning Saws.—Referring to the pruning saw (Figs. 33 and 34, p. 32), we would prefer giving "pull-cut" teeth or M teeth, to the crosscut teeth shown in the illustrations.

A Sensible Pruning Saw, which they use out in California, has teeth pointing toward the handle, and find that it will trim off a shoot neatly where a push-cut blade would tear all before it; and when it comes to stouter limbs the weight of the body can be put on it.

The Butcher's or Meat Saw (Fig. 291) has a straight blade strained by a screw in a somewhat elastic back frame or bow. It

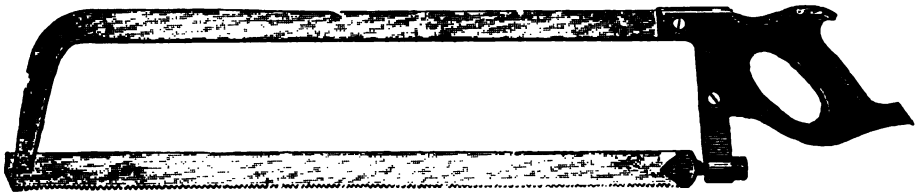


Fig. 291. Butcher's Saw.

has no set, as the tough, hard character of the bone requires none; and clearance is not very necessary where the walls of the cut are so thoroughly lubricated by grease.

Table and Compass Saws should be thinner at the back than on the cutting edge, to prevent pinching.

"Crosscut" Sawdust is granular, but "rip" sawdust should be in the form of chips.

How to Choose a Saw and Keep it in Order.—"In selecting a saw it is best to get one with a name on it that has some 'reputation.' If a man desires to purchase a first-class watch, he selects a maker who has attained a reputation. This remark applies in the choice of a saw or any other tool. The first point to be observed in the selection of a handsaw is to see that it 'hangs' right. Grasp it by the handle and hold it in position for working. Then try if the handle fits the hand properly. These are points of great importance for comfort and utility. A handle ought to be symmetrical and the lines as perfect as any drawing. Many handles are made out of green wood; they soon shrink and become loose, the screws standing above the wood. Handle wood should be seasoned three years before using. An unseasoned handle is apt to warp and throw out of truth. The next thing in order is to try the blade by springing it. Then see that it bends regularly and even from point to butt in proportion as the width and gauge of the saw vary. If the blade is too heavy in comparison with the teeth, the saw will never give satisfaction, because it will require more labor to use it. The thinner you can get a thin saw the better. It makes less kerf, and takes less muscle to direct it. This principle applies to a well-ground saw. There is less suction and friction on a narrow, true saw than on a wide one. You will get a smaller portion of saw blade, but will save hundreds of dollars' worth of manual labor at a very little loss of width of blade.

"See that it is well set and sharpened and has a good crowning breast; and get a proper light to strike on it; you can then see if there is any imperfection in grinding or hammering. 'We should invariably make a cut before purchasing a saw, even if we had to carry a board to the hardware store.'

"Handsaws should be set on a stake or small anvil with one blow of the hammer. A high-tempered saw takes three or four blows of the hammer, as they are apt to break by attempting to set with only one blow. This is a severe test, and no tooth ought to break afterward in setting, nor will it if the mechanic adopts

the proper method. The saw that is easily set and filed is easily made dull.

"We have frequent complaints about hard saws, but they are not as hard as we would make them if we dared; but we should never be able to introduce a harder saw until the mechanic is educated to a more correct method of setting his saw. The principal point is that too many try to get part of the body out of the plate, when the whole of the set must be got out of the tooth—setting below the root of the tooth distorts and strains the saw-plate. This may cause a full-tempered cast-steel blade to crack, and eventually break at this spot; but it is always an injury, even if it does not break or crack."

Hardening Saw Points.—A Canadian patent of N. Wharton is for hardening the points of the teeth of a mill saw more than their base and the blade. As the teeth ultimately wear away by filing, we cannot see where the advantage of leaving the bases soft comes in.

Round Saw Back.—A patent was taken out on a round bar for a tenon saw back, the blade not being gained into the bar, but touching it along its entire length.

Making very Small Straight Blades.—Where it is required to make very fine teeth, as for small scroll saws, hack saws made from watch spring or "hoop-skirt wire," the teeth may be made regular in space, depth, and pitch, and the work greatly facilitated by the use of a guide, seen in Fig. 292. This is simply a steel rod

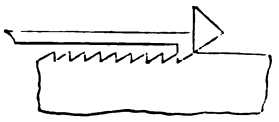


Fig. 292. Making Small Straight Blades.

with the end upset and filed to fit the required tooth outline. The first notch being made (that at the point) the guide is applied therein and the file used against it, moving the guide on one space as each new tooth is made.

Lengths, Sizes, and Spaces of Unstrained, Unguided Saws.—(Class 4) expressed metrically, and corresponding to table on page 30.

		Length, Cm.	Thickness. Inches.	Thickness. Millim.	Points per decimeter = 3.937 inches.	
Taper	Hand,	66.04	.042	1.0668	20 to 48	
	Rip,	71.12 to 76.20	.049	1.2446	12 to 20 / 24 to 32	Heel. / Point.
	Panel,	35.56 to 60.96	.028 to .035	.7012 to .8890	32 to 48	
	Compass,*	25.40 to 50.80	.065	1.7510	.....	
	Keyhole,*	17.78 to 22.86	.032	.8128	.....	
Backed	Tenon,	15.24 to 45.72	.028 to .035	.7012 to .8890	44 to 60	
	Miter,	50.80 to 76 20	.035 to .042	.8890 to 1.0688	40 to 44	

Barthelme's Reaming Saw (U. S. Patent, No. 239,698. April 5, 1881).—There are three kinds of tapering teeth, *b*, *e*, *g*, placed in line. Teeth *b* having inclined cutting edges *a*, teeth *e* having oppositely inclined cutting edges *d*, and teeth *g* having flat edges *f*, the operation of the saw is to produce a triangular groove.

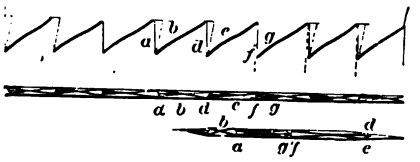


Fig. 293.

* For curved sawing.

CROSSCUT.

The Crosscut Saw.—The ordinary crosscut saw, among the most primitive and most generally used implements, is one of the advance couriers of civilization. It penetrates the forest almost with rifle and axe, and far in advance of the surveyor's chain, and once it enters a country it stays there. It remains a useful member of society, despite its crudity. It is its very simplicity that has caused it to be so tenacious of its position among needful implements. It requires no foundations, no motor, no special preparation. Where the axe leaves a tree, there the crosscut takes it; and from the newly fallen log upon the virgin shores, to the busy ship-yard that succeeds the primeval forest, the crosscut is never hung up. And yet it is an aggravating, fatiguing, slow-working affair.

Disadvantages of the Crosscut.—In the first place, it requires great muscular exertion from the weakest muscles of the body. In the second, it not only develops one side of the body at the expense of the other, but by unnecessarily fatiguing one side without giving it any reserve member, it lessens the capacity of the operator, already working at a disadvantage, with weak muscles, to do heavy work. In the third place, in most positions, where the log lies upon the ground, the position of the sawyer is uncomfortable, unhealthy, and still further lessens his capacity for work. In the fourth place, the operator must often clear away a space in the brush and snow for room to work in.

In this country especially there have been many improvements made in the crosscut, as in all sawing implements. The heavy bow-frame of sapling sprung into an arc, still used by the cross sawyer in Europe, has no place here. The curved edge of the blade has been brought from the top to the bottom or cutting edge, in order that as the saw wears away the middle (as it naturally does) the wear of the blade may be taken up, and still leave it a capable tool. In the third place, the shape of the teeth has been very carefully chosen to suit various requirements. Cross-

cutting has become a regular cutting, and not a mere abrasion. The M tooth has been employed to give the best cutting edge with the best facility for sharpening. Perforations have been introduced along the line of the gullets to lessen the time, labor, and expense of filing, while insuring that the teeth remain at the proper distance and size, and perhaps cooling the blade. The gullets are made deeper in the centre of the edge than at the ends, for the same purpose that the cutting edge itself has been made convex. The handle has become a convenient affair by which the tool may be firmly grasped and guided, and modifications have been introduced by which one man may do very heavy cross-cutting. But with all these improvements the crosscut wears a man out, makes him lop-sided, and uses only the muscles of his arms and shoulders. The disadvantages have led to the rapid introduction of the "riding drag saw," of which an illustration is given, Fig. 27, page 29.

Taper Gauge.—The crosscut, more than any other saw, requires to be tapering in gauge, as shown in Fig. 294; the back *a*

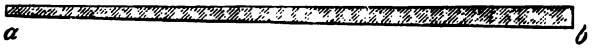


Fig. 294. Section Showing Taper.

being thinner than the edge *b*. Where there is not enough taper, enough set must be given to effect the same result.

Belly.—The crosscut blade is always made wider in the middle than at the ends (frequently twice as wide), and this extra width is generally put on the cutting side—to counteract the rocking tendency of the sawyer, and to allow for the extra wear that the middle of the saw gets. Very often there is a section of fine teeth at each end of a crosscut, to start with; and some makers put deeper gullets in the central portion, to give more dust room, and save time, files, and gumming. (See Fig. 295.)

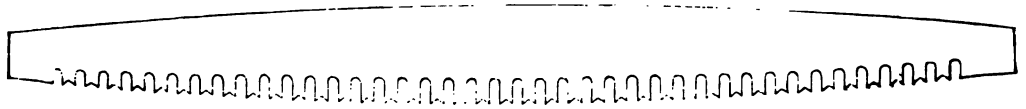


Fig. 295. Swelled Blade, with Graduated Gullets.

Perforated Crosscuts.—Out in the backwoods, among snow and underbrush, where emery wheel gumming machines are not get-at-able or usable, perforations in crosscuts are special blessings to sawyers. But perforated blades are not at all recommended for gummy timber.

A correspondent writes: "As to perforated teeth, I am entirely at loggerheads. A very little is saved in gumming, but the liability of breaking out in the cut is so great that it destroys their usefulness. I have seen a perforated tooth saw with four or five teeth gone right in succession. This was done by first breaking off one tooth in a hard cut in an oak log in winter.

"The theory of allowing for fluttering by perforations does not hold good at all. I have seen these saws flutter and roll the same as any saw worn at the edge."

The Varieties of Crosscut Teeth are legion—hook, crook, double hook, double crook, **V's, M's, W's**, and all their variations and combinations, with cleaners or plows in every possible alternation; and each or all of these in infinite difference of acuteness, set, rake, and cross-angle.

Fig. 296 shows in full size an arrangement of teeth of crosscuts very popular in some quarters. The scorers or cutters are single teeth with alternate fleam to left and right. The cleaners or plows are of course shorter than the cutters; they are double, and have no fleam. We approve of the idea of giving no fleam to cleaner teeth, but highly object to the square-shaped gullets between the teeth, and also to the notches in the plows. These should have rounded outlines, which are easier to make and leave a stronger plate.

Of the crosscuts made by the American Saw Company, and illustrated on pages 43 to 47 inclusive, the Premium is the most sold and the Champion next.

The "Climax" Crosscut, page 40, has cutting teeth in combination with clearing teeth, placed *face to face*, and not *back to back*, as is the usual manner.

The Lightning Crosscut.—Among its advantages, not enumerated in the first edition, may be mentioned the fact that teeth

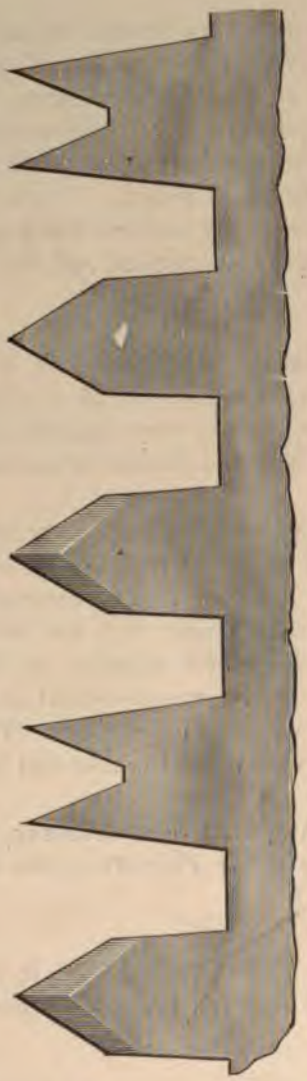


Fig. 296. Crosscut.

Fig. 297.
Double Skew Taper Blade.

of uniform length are easier to sharpen than where the clearers are shorter than the cutters; and as the teeth are double and the gullets arch-shaped, they may be gummed deeper than V-toothed blades—thus saving expense and frequent repairs.

The New American Crosscut was recently brought out to accommodate the tendency towards more *cutting* teeth.

Fig. 297 shows a form of two-man crosscut, which has convex cutting edge and a double curved taper on the back, corresponding somewhat to the "skew bevel" hand saws of the same eminent makers. In this saw, as toothed in the cut, the teeth are plain Vs, set and fleamed alternately to left and right; but of course any style of tooth will go with this style of plate; the cut being given only to show the outline of the blade.

Handles for Crosscuts.—The log crosscut in some parts of Europe has a stout straining bow of wood, for some purpose to the writer unknown. Possibly saw makers there cannot make their saws stiff enough to keep straight, even with a stout man at each end. Our American manufacturers are especially strong on convenient crosscut handles, readily and firmly attached to the blades, and of a comfortable shape.

Peace's Crosscut Handle (U. S. Patent, No. 238,960, March 15, 1881, Fig. 299) has two adjustable curved plates *B B'*; *B*

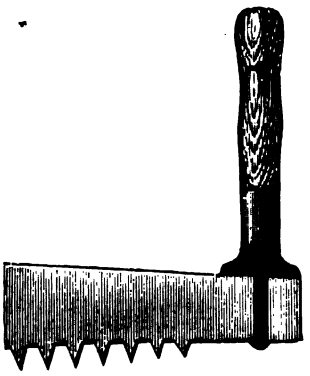


Fig. 298. Crosscut Handle.

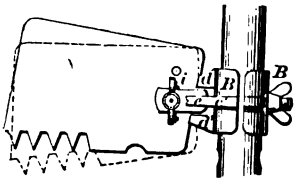


Fig. 299.
Peace's Crosscut Handle.

having four projecting arms *c c'*, *d d'*, one arm being shorter than the others, and all so arranged that by a bolt and thumb nut *i*, the handle may be secured on the plane of the saw blade or at an angle thereto, without being moved therefrom.

Emerson's Crosscut (U. S. Patent, No. 239,156, March 22, 1881) has sections *B*, having scoring teeth *b b'* in pairs, one pair, *b*, set to one side of the blade and the other pair, *b'*, set to the opposite side. There are also sections *c*, having scoring teeth *c* and *c'* with graduated slots or spaces deepest in the centre of the saw. (See Fig. 300.)

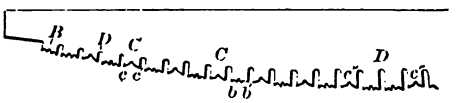


Fig. 300. Emerson's Crosscut.

Boynton's Curving Crosscut Saw (U.S. Patent, No. 239,710, April 5, 1881) has its edges formed with reversed curves or swells, these curves being arranged on each edge of the saw so as to permit its breadth and thickness to be diminished to lessen its friction surface and allow a less set to the teeth without impairing the strength of the saw or rendering liable to buckle. We have no knowledge of these saws having been used. (See Fig. 301.)

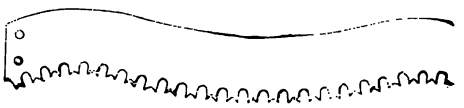


Fig. 301. Boynton's Curving Crosscut.

DRAG AND PIT SAWS.

Pit Saws.—A long time ago, when many ships were built of wood, and their heavy sides were laboriously framed of carefully sawed timbers, "pit-sawing" was much in vogue, and was also a common method of getting out straight boards and planks from the round or squared logs. The pit sawyers had a long taper blade (Fig. 302), a "pit" or "whip" saw, having a handle at each end, and the "top sawyer" and "bottom sawyer" pulling one in, the other above, the saw pit, made alternate bows, and slowly worked their way through the log's length. Sometimes these saws were held in a rectangular straining frame, which did not make the upstroke any the easier. This straining frame was the precursor of the "gate" or "sash" of the present day.

Double Cutting Butting Saws (Fig. 303) are now coming more into use, and still in many cases called "drag" saws, although they cut on the thrust as well as on the drag stroke.

Depth of Drag Saw Cut.—The cut of the drag saw may be deepened by weighting the blade; a sliding weight being supplied, with a set screw to hold it in any desired place to give the desired leverage.

Fig. 302.
Pit Saw Blade.

Fig. 303.
Double Acting Butting Saw.

THE JIG SAW.

Jig Saws.—Henry L. Beach, Jig Saw Maker, Montrose, Pa., states that strained jig saw blades "are made all lengths and all widths from $\frac{1}{8}$ to $\frac{3}{4}$ wide, and from 13 to 18 inches long. Nearly all the saws used in my machines are 18, 19, and 20 gauge. Those $\frac{3}{16}$" wide should have 8 points; $\frac{1}{4}$", 7 points; $\frac{3}{8}$", 5 points; $\frac{1}{2}$", $4\frac{3}{4}$ points to the inch, and run with as little set as possible for smooth work. For heavy sawing I often use saws 16 inches

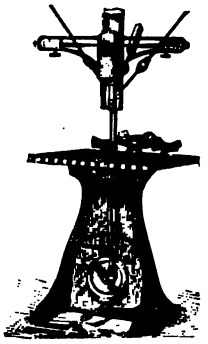
Fig. 304. Fret Saw Work.

long, one inch wide at the upper end, $\frac{3}{4}$ or $\frac{5}{8}$ at the lower end, with three teeth to the inch. I consider the taper saw a good thing for heavier classes of work, but for ordinary sawing the

Fig. 305. Pryibil's Jig Saw.

straight saw is the best. Some sawyers use bevelled backs, saws ground thin on the back and left thick on the front. These require no set and work smooth. The objection is that the feathering weakens the blade too much. Have never seen any round saws; they must, however, prove a failure so far as doing smooth work and making smooth corners, which is desirable. The best stroke is 5¼ inches for all kinds of work, and the speed should be 850 to 900; 1000 to 1400 speed is often advertised to be the best, and in machines giving little or no strain a high speed is desirable, but it is death to the machine. 850 speed with 50 lbs. strain will do more work, do it better, and the machine will stand it."

Strained vs. Unstrained Scroll Saws.—"Saws not strained by a spring above the table become convex on the back edge and can be used only on thin, light work, while strained jig saws are actually at use at present upon 'piano desk work,' and are producing more work than the gate-saw, which has always been thought to be the only one which could be advantageously used for the purpose."—P. PRYIBIL.



THE MULAY.

The Mulay has an unstrained blade, driven from below and guided at the top in ways, and by reason of the absence of the heavy straining frame, capable of high speed and great output. It cuts, of course, on the pull stroke only. For log sawing it is used, principally in the Western States of America, in places where there is but small water power and but a limited amount of sawing. For scroll sawing its use has extended both east and west from Cincinnati, where it is said to have been first used for this purpose. The only advantage the sash has over the mulay is, that a saw so wretchedly filed that it would be impossible to run it through a log as a mulay, can be pulled through a log when strained in a frame. But it will not, however, make straight lumber even when thus strained. As a log mulay should make about 300 to 350 strokes per minute, all the moving parts (especially the reciprocating parts) should be as light as possible.

Snyder's Mulay.—In one of the best forms known to us (Snyder's), the lower end of the blade is held in a cross-head running between guides, and the connection between the saw and cross-head is a ball-and-socket joint, so that the blade can be easily adjusted to run in line with the carriage, and also be given the proper rake. The upper guide, which is lifted by the blade itself, needs to be specially light, and is made of wood. As it is lifted by the blade and friction tends to buckle the blade no less than weight does, it should fit very loosely. But as the cross-head ordinarily employed would, if it had a loose fit, permit the blade to move from its proper adjustment in the centre line of the carriage, a new mode of guiding has been devised. The entire machine is seen in Fig. 306.

Fig. 307 shows the old and the new way of guidance. In the old plan, where the cross-head and guides were at right angles to the width of the blade (see B, B), a very little looseness of fit gave considerable disalignment. But, by clamping the blade D between wooden pieces C, parallel with its width, and putting the ways fore and aft, as at E, E, considerable play may be allowed in

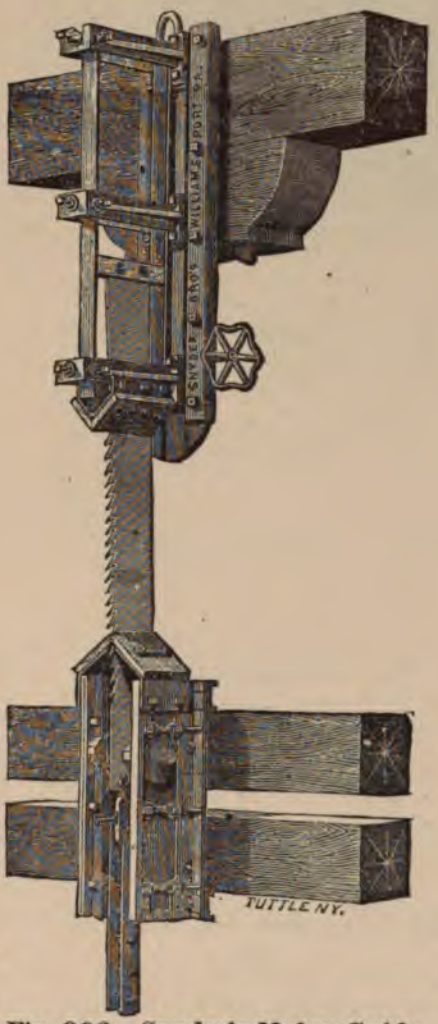


Fig. 306. Snyder's Mulay Guide.

Fig. 307. Comparison of Mulay Guides.

the guides without the blade getting out of the centre of the kerf line. Diagonal boards (Fig. 307) help guide the blade, and are adjusted so as to just clear the log and help to guide it above. They are adjusted by a rack and pinion, and hand-wheel.

For log sawing the blade is generally 10″ to 12″ wide, and $\frac{1}{4}$″ thick as a maximum, $\frac{1}{9}$″ as a minimum; the most common gauge being No. 7, or about $\frac{3}{16}$″. The stroke for a 7-foot mulay is generally 28″.

Andrews' Mulay Fastening is shown in Fig. 308. A is the blade, B the permanently attached clamp, C the movable strap

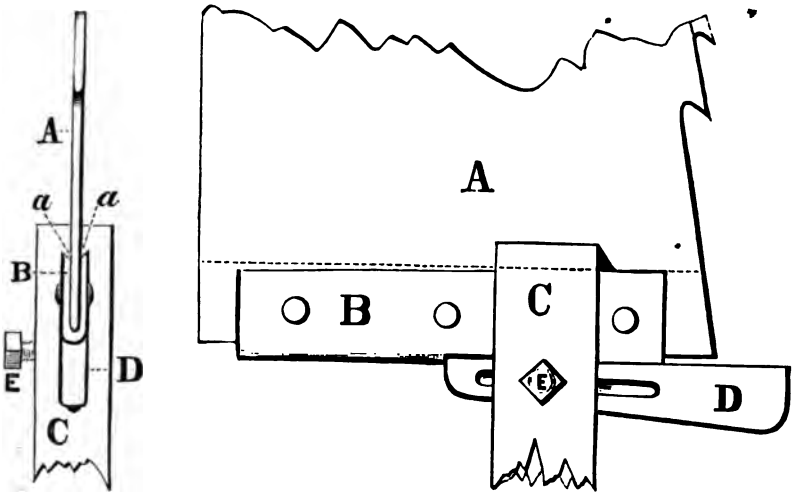


Fig. 308. Andrews' Mulay Fastening.

and bolt, D the wedge, and E the holding bolt. It will be seen that as the saw plate wears away, C can be run backwards; and that all desired adjustments can be readily made. The strap C holds to the clamp by the hooks *a a*.

Mulay Saws on the Pacific Coast.—Mulays are very little used on the Pacific coast. As far as we can learn, none are in use on Puget Sound, and only a few in Mendocino and Humboldt, the great red-wood districts of California. There they are employed in a few mills only to take the slabs off the largest logs to reduce their size.

Some of these mulays are wider at the top than at the heel. These are thought by some to cut better and make a lighter saw than the straight blades, and to have more strength at the top where it is needed.

"**Mulays for Log Sawing** are but little used, except in mills where there is but a limited amount of sawing."—[J. A. FAY & Co.]

THE SASH.

The Object of the Frame or Sash is to secure guidance in right lines, and to enable the use of a thin and narrow blade.

The Single Sash is sometimes used where it is desired simply to rip a log to show its quality at the heart.

The Two-Bladed Sash serves to square a log in two passes. It is much used for this purpose in France.

Gang Mill Sawing Machines are used in America only in the large lumber districts. They are known as *round* or *flat*, according as the logs they slit have or have not been previously squared on two sides.

Round Gangs are more economical of timber than flat; the boards being afterwards "edged" square by small circulars.

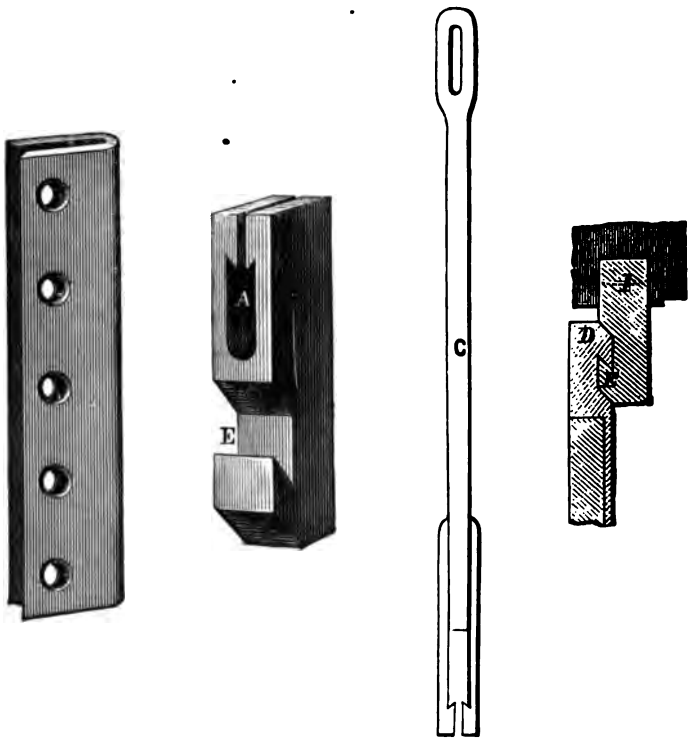
The Strain upon a gang sash is often 5 to 6 tons per blade.

Straining Sash Gangs.—The mode of hanging the blades is deserving of special attention. Improved American usage (such, for instance, as that of E. Andrews, of Williamsport) is, in this respect, far superior to foreign. It is well known that, with proper straining, very thin saws can be run; while it is difficult

to make even a thick saw work well when not properly strained. When blades are strained by holes and tug-pins, it is necessary to punch or drill the first hole near the cutting edge, so that that part may receive the most strain. As the saw wears away, another hole is made, of course at some little distance from the first, thus preventing the blade being strained in line with blank space between the holes.

Mistakes in punching or in drilling often cause the saw to be given too much or too little overhang, in either of which cases it will work badly. By the use of the horse and stirrups, shown on page 23, and herewith, the holes are made at the factory, and never changed; the saws being plated with straps at each end, and the rake given simply by moving it more or less in either direction through the top stirrup. Fig. 309 shows a strap; Fig.

Fig. 309. *Fig. 310.* *Fig. 311.* *Fig. 312.*



Andrews' Sash Fastenings.

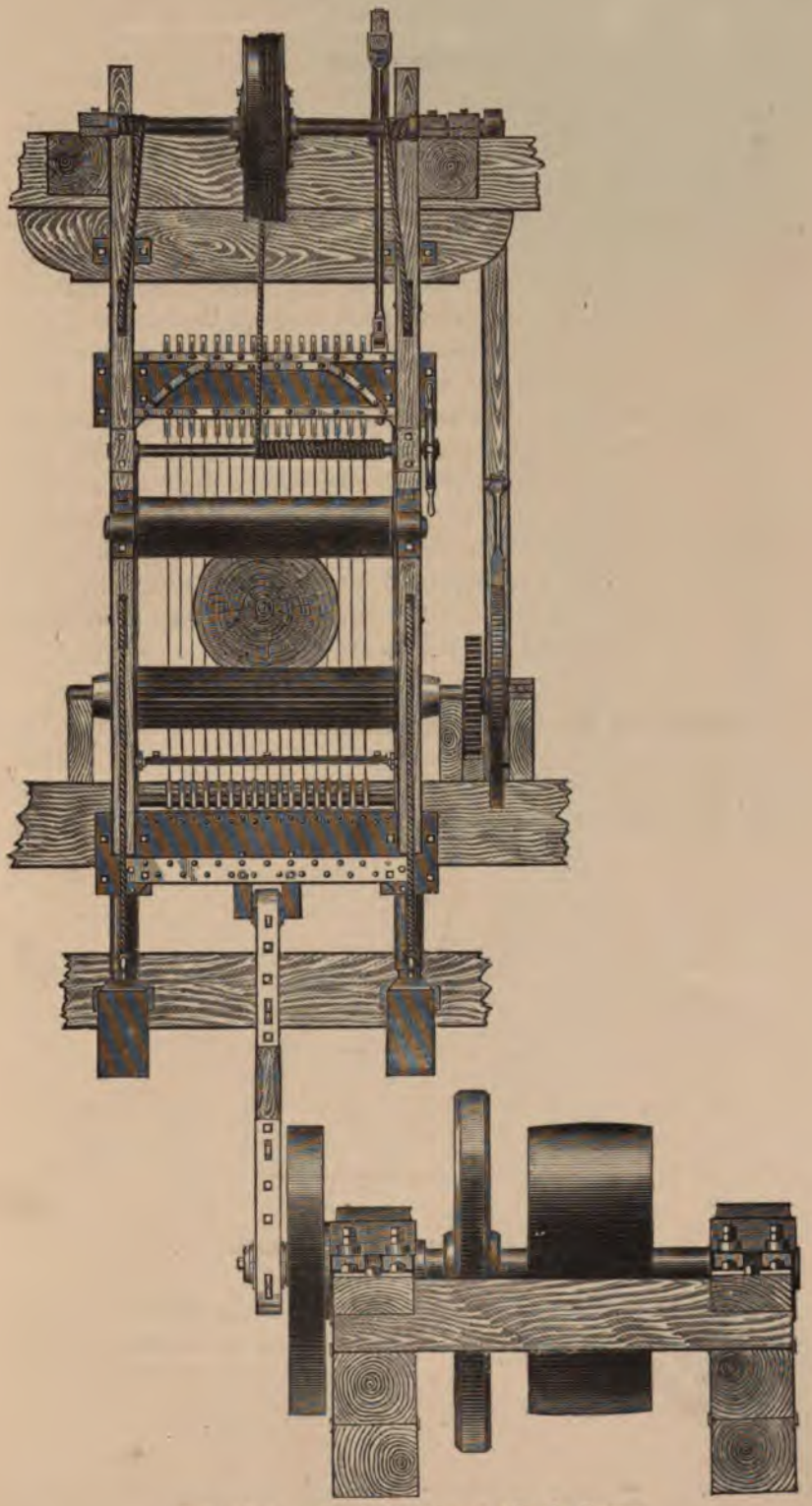


Fig. 313. Snyder's Round Sash Gang.

310 the bottom hook; Fig. 311 the top stirrup on a smaller scale; Fig. 312 is the hook attachment for the lower end of the blade to the lower girt. As the blade wears away, the strain line may be moved back by moving the hooks along the straps. This arrangement permits instant changes in the rake, to accommodate either hard or soft wood. In fitting a gate for these hooks, all that is necessary is to drill three holes through the bottom girt of the gate and attach a flat piece of iron. This holds the hooks in place on removing the saw, and prevents them from falling when the saw is removed. One set of hooks answers for any number of blades. The lips of the hooks and of the stirrups are made on a circle to prevent straining at the corners where the blade is given rake or overhang. Some sawyers of experience find thin saws to work best when part of the desired rake is given by packing the top bar of the gate, to bring the strain more nearly on a line with the bottom of the saw teeth. This invention has been thoroughly tested, and proved to be all that is claimed for it.

"Rake" for Reciprocating Blades.—It is desirable that the straight line which passes through the tooth points be inclined forward, or "raked," to let the cant advance when the blade rides. (See Fig. 314.) This rake should be so regulated that the blade

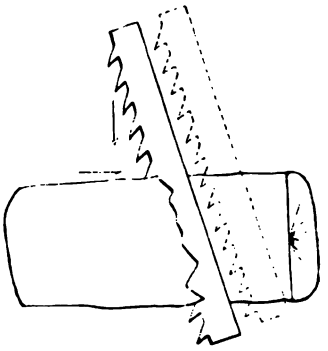
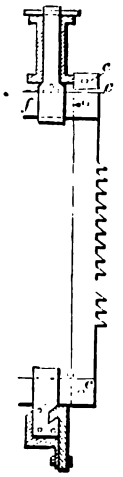


Fig. 314. Exaggerated Rake.

in descending shall not pass, during part of the stroke, through the kerf already made—as this would lessen the capacity of the machine.

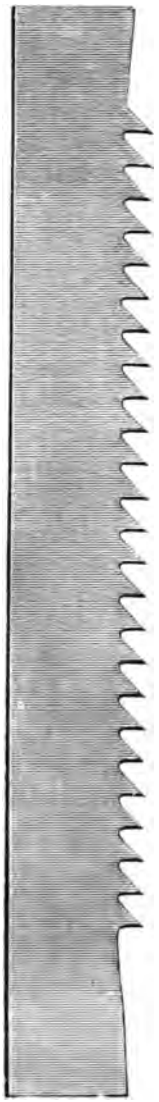
Snyder Bros.' Rule for Rake is "give $\frac{1}{16}$" more than the feed in the same length. Say feed $\frac{1}{2}$", crank 12", the saw should have a rake of $\frac{9}{32}$" to the foot."

Fig. 315.



Hubbard's Sectional Mill Web.

Fig. 316.

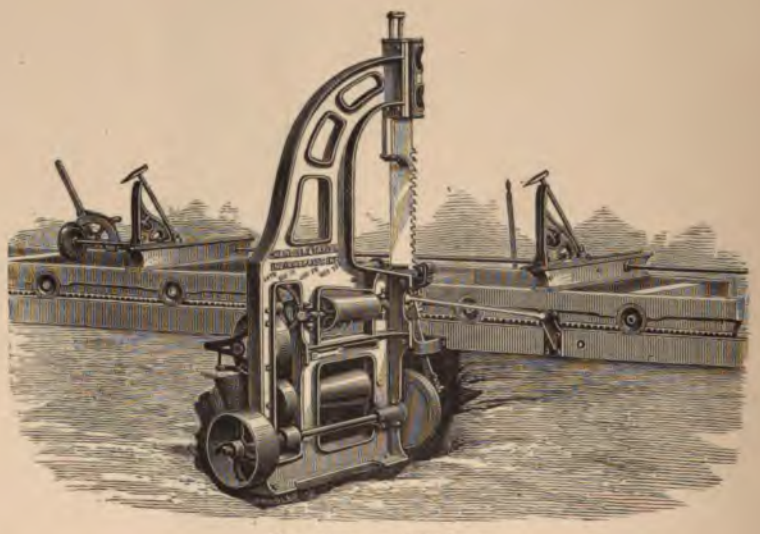


Usual Type of Mill Saw Blade.

Hubbard's Sectional Saw (U. S. Reissued Patent, No. 9657. April 12, 1881) consists of longitudinal sections—the front section, which is the saw proper, having teeth, and the other sections being blank, and of a thickness equal to or less than that of the front section. Sections are so connected as to permit of independent longitudinal expansion.

Double Cutting Sash Saw.—The strained sash saw originally cut on one stroke only; not cutting on the return. There are now horizontal strained saws which cut both ways; and one or two vertical machines which do the same thing imperfectly.

Double Cutting Mill Saws with single cutting teeth, one half pointing one way, and the other in the opposite direction, have been patented by T. Davis.



Overhung Mulay.

Statistics of Mill Saws. (WORSSAM.)

TIMBER FRAMES.

Size of Frame.	Space, Pitch, and Depth of Tooth (gullet).								Length of Saw.	Width of Saw from the back of the point to tooth.		Gauge of Saw.		Length of Stroke.	No. of down strokes per minute.	Average No. of horse power for each frame.
	Soft Wood.				Hard Wood.											
	Space.	Pitch.		Depth.	Space.	Pitch.		Depth.		Top.	Bottom.	Soft Wood.	Hard Wood.			
		Face.	Top.			Face.	Top.							inch.		
12″	3/8″	80″	32″	1/4–3/8″	5/16″	90″	32″	1/4–5/16″	3–1 3/4″	4 or 3 1/2″	3 5/8 or 3 1/4″	16	16	13	235	4
18		"	"	1/4–1/2		"	"	1/4–3/8	4– 3/4	4 1/2 or 4	4 1/8 or 3 5/8	16	16	16	190	6
24		"	"	1/4–5/8		"	"	1/4–7/16	5–2	5	4 1/2	15	15	19	160	7
30		"	"	1/4–3/4		"	"	1/4–1/2	6–10	5 1/2	5	15	14	22	140	8
36	7/16–1″	"	"	1/4–7/8		"	"	1/4–9/16	6–10	6	5 1/2	14	14	25	125	9
42	1/2–1	"	"	1/4–1		"	"	1/4–5/8	7–4	6 1/2	6	14	14	28	110	10
48	1–1 1/16	"	"	1/4–1	1/4–1	"	"	1/4–5/8	8	7	6 1/2	14	13	31	100	11
54	1–1 1/8	"	"	1/4–1	1/4–1	"	"	1/4–5/8	8–9	7 1/2	7	14	13	34	90	12

DEAL FRAMES.

11″	3/8″	80″	32″	1/4–3/8″	5/16″	90″	32″	1/4″	3– 3/4″	3 1/4″	3″	17	17	12 1/2	245	3
14		"	"	1/4–1/2		"	"	1/4	3–4 1/2	3 1/2	3 1/4	17	17	14	215	4
18		"	"	1/4–5/8		"	"	1/4	3–9 1/2	3 3/4	3 3/8	16	16	16	190	5
20		"	"	1/4–3/4		"	"	1/4	4–1 1/2	3 3/4	3 3/8	16	16	17	180	5 1/2
22		"	"	1/4–3/4		"	"	1/4	4–4 1/2	3 3/4	3 3/8	16	16	18	170	6
24	7/16–7/16″	"	"	1/4–3/4	1/4–1/2	"	"	1/4	4–5 1/2	4	3 3/4	16	15	19	160	6 1/2
26	1/2–1/2	"	"	1/4–3/4	1/4–1/2	"	"	1/4	4–8 1/4	4	3 3/4	15	15	20	150	7
Planking Frame.	7/16–7/16	"	"	1/4–3/4	5/16–3/4	"	"	1/4	5–6 3/4	4	3 5/8	15	14	22	140	8 1/2

EXPLANATORY REMARKS.

FRAMES.—The depth of timber to be sawn governs the size of frame: thus a 12″ frame is to cut 12″ deep.
SPACE.—The space is the distance from tooth to tooth, measured at the points.
PITCH.—The pitch is the inclination of the tooth-face up which the shaving ascends, and is measured with the tops of backs of the teeth, in degrees, from a line passing through the points.
GAUGE.—The gauge referred to above is generally known as Stub's *Birmingham Wire Gauge*.
STROKE.—The stroke should be equal to depth of material to be sawn, but in practice the tabulated dimensions are found sufficient.
GAUGE OF SAW.—In converting deals into thin stuff the gauges of saws must be somewhat modified; thus, over 7 cuts all blades should be 1 gauge thinner, 10 cuts 2 gauges, 13 cuts 3 gauges.

CIRCULAR.

Thickness of Plates.—Circulars are used thinner in Wisconsin than in Michigan. For instance, 60-inch disks are used as thin as 10 gauge (0.134 inch), having teeth 2½ inches apart. The Wisconsin timber may be a trifle softer than the Michigan (being more like Norway pine); but our informant considers the sawyers more skilful. The gauge demanded depends upon the kind of timber and its general condition, but more upon the amount of care displayed in the management. Generally, the thicker the saw the more you can force matters and have it run straight. For general sawing in New England, 7 or 8 gauge straight is recommended as about as thin as practicable, for board saws 46 to 60 inches in diameter.

Rim Tapering.—Referring to the modern American system of rim tapering, Mr. C. E. Grandy says: "I have obtained the best results from 7-gauge straight, and do not fancy using wedges for saws. In every case of rim taper, I notice that the sawyer has to use enough set to clear the centre, or his plate would warm. If this be so, of what use is it to have the three gauges ground off at the edge? In sawing thin boards only, or resawing with a thick spreader, this is all right, as there is a saving of kerf* and greater stiffness of the saw obtained by the rim taper."

Number of Teeth for Circulars.—The same sawyer says: "I have settled on forty teeth in common board saws, say from forty-four to fifty-four inches in diameter. Too many teeth consume too much power. If there be too few, they are not strong enough to stand the average work."

Dished Circulars.—A distinction must be made between a "dished circular," made with a permanently and intentionally dished plate, and a "dishing" circular, intended to be flat but having got "rim-bound."

* Kerf is sometimes called "scarf," and also written "carf."

The dished circular was designed in 1806, by Trotter, for the purpose of curved and bevel sawing.

The temper of a concave saw, in our opinion, ought to be a good and as high as any ordinary circular doing the same nature of work. The custom has been to leave the saw much softer, to avoid breaking in the hands of the saw-maker; but a soft saw will not hold the set when cutting hard wood heading. The disk is made to a true circle, and in diameter corresponding to the heads it is to circle, providing the heads are cut square on their periphery, as cheese-box heads are made. To make a seventeen-inch cheese-box, use a saw dished to a circle of seventeen inches; and for a seventeen-inch flour-barrel head, with bevel, use a saw dished to a circle of twenty-four inches. The same saw may be used for making various sizes of heading having bevelled edges, by changing the angle of the axis of the head in relation to that of the saw. In that case the bevel on the heading is also changed or altered to suit the saw. In a small head they are sharper, and in a large head stunted. Concave saws, sawing bevelled heading, must be filed as a ripping saw, or square across the tooth.

Cutting Action of Circular Saw.—Fig. 317, photo-engraved from a full-sized sketch, shows the action of a 60-inch saw cutting in a 20-inch cant. As shown by the photo-reduction of the actual-sized drawing, the radius of the saw is 30 inches, thickness (or light) of the cant 20 inches, radius of collar 4 inches, radius of arbor $1\frac{1}{2}$ inch. The cut shows 10 successive positions of the saw disk, in passing through the log. The 10 arcs of circles are drawn with radii of 30 inches, 3 inches apart. Each arc is exactly a quadrant or 90°. Each of these arcs touches the base line or line of centres at a point 30 inches from its centre. The centres being 3 inches apart, the distances between the arcs, showing the position of the rim upon the line of centres, are each exactly 3 inches. Running verticals from the successive positions of the centre, 3 inches apart, all these verticals are 3 inches apart. Running a horizontal line along the points of tangency, parallel to the line of centres and perpendicular to the verticals from the successive positions of the centres, it will be seen that the distances between the points of tangency, measured upon this line of tangents, are the same as

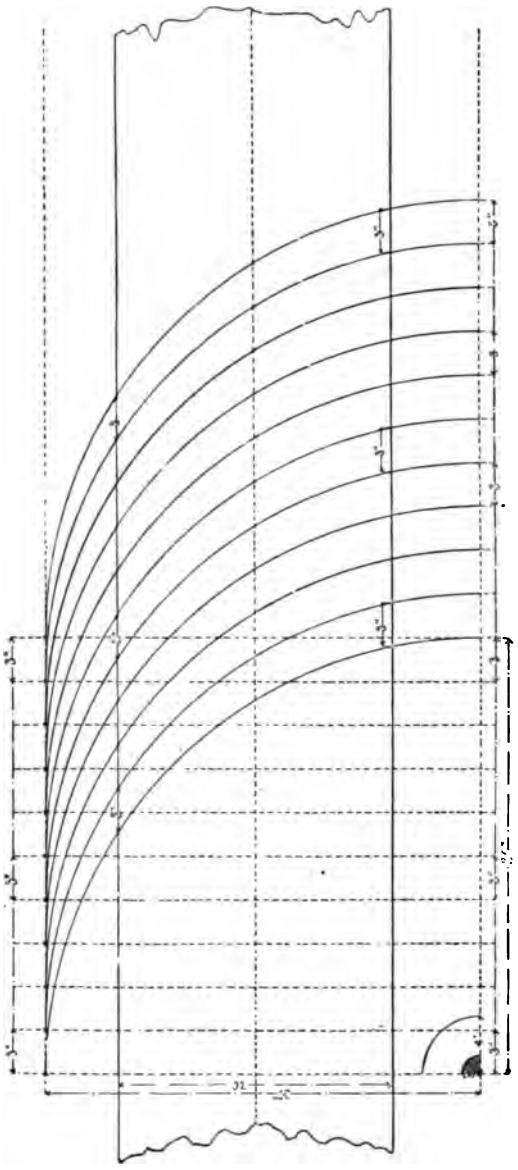


Fig. 317. Cutting Action of Circular Saw.

those between the centres, the same as between the successive positions of the rim upon the line of centres, and the same as the distance between the verticals. The sides of the cant are

parallel to each other, to the line of centres, and to the line of tangents. The distances between the verticals from the successive positions of the centres, are, if measured upon the top edge of the cant, or upon the bottom edge of the same cant, the same as measured upon the line of centres, or upon the line of tangents, or anywhere else—just 3 inches. The distance between the curves showing successive positions of the saw rim upon the top edge of the cant, is just the same as the distances between the centres, between the verticals, and between the points of tangency—namely, just 3 inches. The distance between the curves showing the successive positions of the rim upon the bottom edge of the cant is the same as that between the centres, between the points of tangency, between the verticals, and between the successive positions of the rim, measured upon the line of centres—namely, 3 inches. The horizontal distance between the successive positions of the rim, measured along *any* line parallel to the line of centres, the line of tangency, the top edge of the cant, and the bottom edge of the cant, is just 3 inches. It cannot be made to measure more, nor less. It can be proved geometrically, and it can be measured by any one having 30 inches of string to draw sharp circles, and a 2 foot rule to draw and measure the straight lines.

Owing to the advancing movement of the cant, the scratches made by the teeth of the saw are not exactly circles, but they follow the same rule, as regards their distances apart, as do the circular arcs showing the successive positions of the saw rim.

In other words, the saw scratches are the same distance apart measured along the top edge or the bottom edge of the cant.

If they were not, it would be necessary for the *top edge of the cant to be different in length from the bottom*, or for the cant to be fed in upon an arc of the circle so as to give less feed to the top edge than to the bottom.

In making a drawing on this subject, do not be misled by the parallel curves appearing to meet at the top.

This photo-engraving of the full-sized sketch may be relied upon as settling beyond all controversy the fact that *the tooth scratches made by the circular saw are the same distance apart at the top as upon the bottom of the log.*

"Virginia Rail Fence."—Sometimes a circular gets a notion of running crooked in the edge, even while cold, although not sprung, and when standing seemingly true and both sides alike. In this case it is too large at the rim, and tends to wrinkle, although not enough to show when standing; but the additional stretch, caused by centrifugal force under motion, causes further rim expansion, and dishes the plate on one diameter to one side, and exactly the reverse on the diameter at right angles. This trouble is apt to occur with inserted tooth saws, simply by over-straining the edge by riveting or by too close a fit of the teeth. Dirty or greasy dust or rust in the groove of the teeth, will cause the same trouble.

Trembling or Fluttering at the edge is caused by lack of balance, one side being gummed or filed more than another. An ounce of steel on one side of a saw running at 800 or 900 revolutions per minute, will cause this trouble. See that the teeth are all alike as to size, or, at least there is as much metal on one side of the saw as on the other, counting from any diameter. To cure fluttering, mount the saw on an arbor on two steel straight edges, and file the teeth on the heavy side until it balances. To prevent, use a sheet metal template.

Sawdust Packing.—Sawdust packs in the side of the log and board, sometimes on account of the shape of the gullet. If the tooth be nearly straight, from three-fourths of an inch from the point to the bottom of the tooth next behind, there will be less trouble from this.

Another cause is frozen or slightly thawed sawdust that strikes the side of the log or board, and sticks to it long enough to crowd in between the plate and timber. This occurs when the timber is thawing out slightly, and in this case a little extra set will help the matter.

A "Bull's Eye" is sometimes caused by getting a piece of slab down between the saw and the frame, and the question is whether or not to run out the stock before sending the saw to be hammered.

Grandy says: "This will depend on how close a workman you

are. By giving the saw more set than usual, and reducing the feed, you may run and do fair work, but at the expense of power and good mechanical principles. A better way would be to take a block of hard wood endwise to the grain, and lay the saw flat on the block, bulged side up; take a two pound or three pound hammer, and, by heavy blows, force it down. Lay a piece of thick pasteboard on the saw to receive the blows, and prevent stretching the plate, for if you do this by light blows, you make the matter worse. Try with a straight edge after each blow."

Cats' Tails.—The sawyer is often troubled in cutting sapling pine in the summer, by what are called in Vermont "cats' tails," or the inside bark slipping off and rolling in beside the plate, heating the saw. This may be remedied by filing the tooth considerably, shearing say 20°; that is, about the same as for bolting or cutting off. Shearing is not recommended when the logs are frozen, unless the saw is of unusual thickness.

Crowding the Log.—It sometimes happens that the circular saw crowds the log, and gets warm. Although it seems true when cold, and pains have been taken to file and set both sides alike, it seems impossible to make it run well unless it be given more set on the log side. This is a common trouble with inexperienced sawyers, and the remedy a foolish one, in fact, "getting Satan in to drive out Satan," as the doctors say. If the saw be true the trouble is, that it ranged out of the log; or else the collars, although they may have been right once, are not right from having accumulated rust and dirt on the face of the collar, near the centre. This causes the disk to become crowning on the log side. To remedy this, take an old file, break it off so as to form a scraper or turning tool, fix a solid rest, take out the check pins, and run the arbor quite slowly; hold the tool firmly, and turn off the rust, and, perhaps, a little of the iron, according to the condition of the collar. Use a gauge to test with, and leave the collar a little concave. Clean off the loose collar also, and then if the disk be true and ranged parallel with the line of motion of the carriage, it will probably run straight without the necessity of giving one side more set than the other, or filing one side more shearing than the other, both of which are makeshifts or botches.

Hammering.—In the matter of hammering, if the smith could stand at the brake, and saw 100,000 feet of lumber, after hammering each saw, he could learn more in one year than otherwise in ten.

Temper of Circulars.—Disstons say that a circular saw cannot be too hard (but a handsaw should have a "Damascus temper").

Nonhammered Saws.—Mr. C. E. Grandy, South Barton, Vt., says: "I have such a saw 52″ press tempered to run 900 revolutions, to feed 2 inches in maple often running 30 M feet. The saw took the shape of a tea saucer; returned it to the maker, repressed it, rehammered it, sawed 100 M feet. It took the shape of a worm rail fence most of the time. Then I sent it to another manufacturer, had it hammered to run 800; we sawed 1,000,000 with it; it wore to 49″, and is doing good work now."

The Brooke Removable Teeth (Fig. 318) have claimed for them the following advantages over others of the same class: large throat, hence greater clearance; greater amount of metal to wear away; capability of being swaged; adaptability to very thin plates; interchangeability with the "new" in the same disk.

We give beneath the thinnest disks used with the "Brooke" and the "new" teeth of the American Saw Company.

Nos.	Gauges.	Thickness in inches.	Thickness in mm.
1	4 to 10	.238 to .134	6.05 to 3.30
2	7 to 12	.18 to .109	4.57 to 2.77
3	10 to 18	.134 to .049	3.30 to 1.24
4	12 to 20	.109 to .035	2.77 to 0.89

For hard wood the "*short new*" *removable tooth* No. 1 or 2, is recommended by the makers; and the Brooke teeth may be temporarily replaced by it in the same disks.

To the Operator using "Brooke" Inserted Teeth.—"When changing the bits or teeth, be careful not to drive or expand the rivet so much as to strain the saw plate, nor to head it too much. Place the bit and spring together, and then put the heel of the spring as

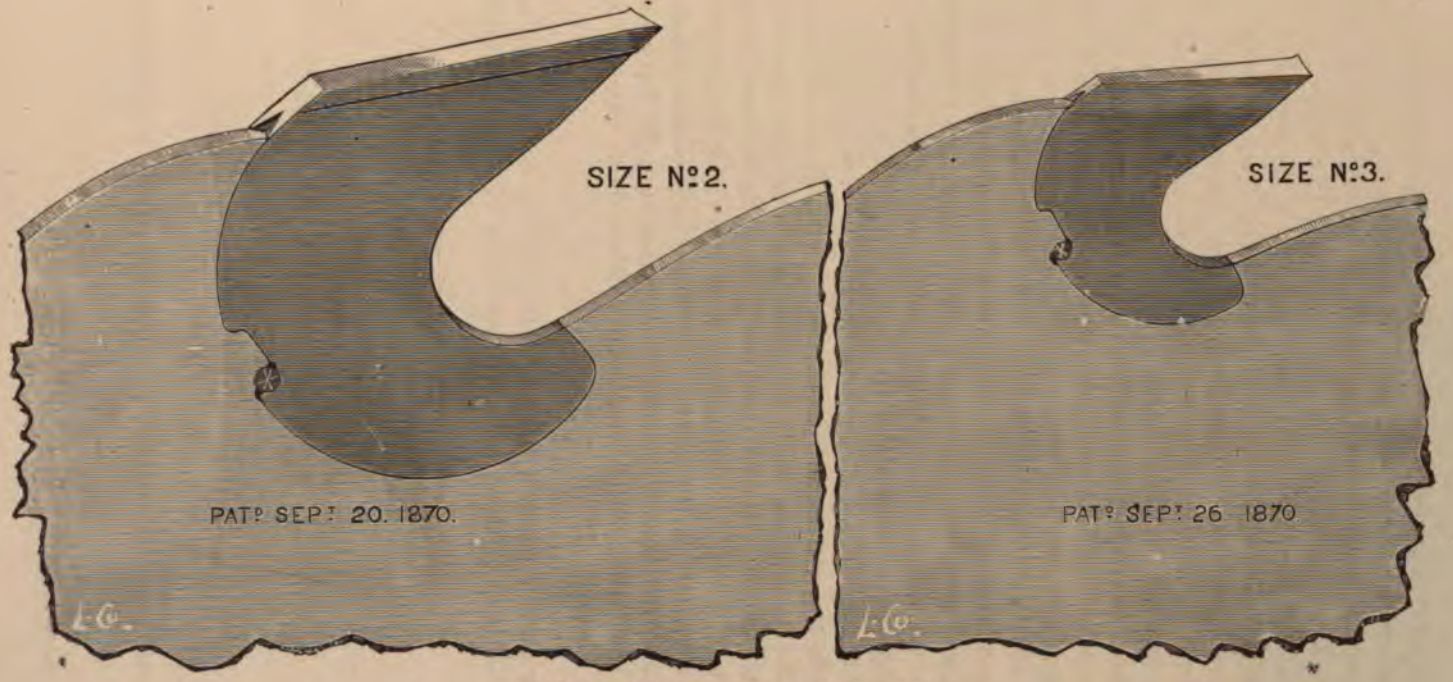


Fig. 318. "Brooke" Teeth, Full Size.

close in its corner as possible, with the point of the plate entered into the groove of the bit, keeping the lower part of the bit with the adjoining part of the spring just clear from the plate sideways, until both are turned into the groove so far that they will drop over the lug into their place. A swage may be used on the point if necessary to bring them to place, and the small end or pin of the wrench to draw the spring down before inserting the rivet. The rivet should be driven or expanded only enough to set the spring firmly in the bottom part. If it is found that the spring does not hold the bit tight enough when the rivet is in, do not try to tighten it by driving the rivet more, but with a light hammer give one or two blows on the side of the spring near the inner or throat edge about opposite the lug and rivet, holding a sledge on the opposite side. This will expand the spring on that edge so that it will press more firmly on the bit. The hand screw-press, with wrench, is used for forcing out the rivet, and makes the changing of bits quick and easy.

"After the bits are in, the first thing is to round and joint off the teeth, and put the saw in working order. If any of the bits are found to stand more on one side than the other, file off the full side. Do not attempt to bend or spring them over, as there is plenty of spread on the point to allow of their being jointed off on the side. Be careful to have the front of the bit the widest.

"One set of these bits should last twenty-eight to thirty days of ten hours each. They have done so where both hard and soft timber were sawed."

New Lumberman's Clipper.—Fig. 319 shows the "Lumberman's Clipper" tooth as at present made. It will be seen to differ

Fig. 319.

from that illustrated on page 77, which has square bottoms to the teeth.

Greatest Number of Teeth in a Disk.—The "Brooke No. 1" may be placed at 4″ apart. The "new" teeth may be placed at the following distances:—

Nos.	"Regular."	"Short."
1	4½	4¼
2	3½	3¼
3	2	—
4	—	1″

Inserted Toothed Circulars seem especially popular in California, Wisconsin, Michigan, and Ohio, and for yellow pine in the Southern States.

Economy in using Inserted Teeth Circulars.—Messrs. R. Hoe & Co., N. Y., write under date of May 10, 1881: "The prices of 54″ and 56″ saws are as follows:—

One 54″ solid circular, list	$105 00	
less 40 per cent.	42 00	
	$63 00	
boxing	2 40	
		$65 40
One 56″ solid circular, list	$125 00	
less 40 per cent.	50 00	
	$75 00	
boxing	2 60	
		77 60
One 54″ chisel tooth, list	$160 00	
less 10 per cent	16 00	
	$144 00	
boxing	2 40	
		146 40
One 56″ chisel tooth, list	$180 00	
less 10 per cent.	18 00	
	$162 00	
boxing	2 60	
		164 60

The prices of chisel tooth saws include the regular number of bits and shanks given with each saw.

"The estimate referred to in your letter, 'cost of inserted teeth to cut 1,000,000 feet of lumber about $35,' is a fair one, though some of our customers have written that they cut with one set of bits in a 56″ to 60″ saw 95,000, 100,000, and even 120,000 feet of lumber."

Inserted Teeth.—C. E. Grandy writes: "In the matter of inserted toothed saws, I have used about every style made. Here, again, is too fine a theory for the average sawyer or even saw-maker to carry out.

"Where keys as rivets are used, they are almost certain to buckle the edge of the saw. If the saw-maker succeeds in getting the right tension on the edge, the sawyer by the time he puts on a new set, or even puts in a few teeth, he is sure to spring the saw.

"It is proverbial in New England that one is 'leaning up against the side of a mill like an inserted tooth saw.' You will find one in most every mill, but they are superannuated, awaiting further orders.

"The style of turning in on a circle gave the best results where the tooth is held like a circular. In one of which I know the manufacturers did not get the tension right the first or second time. Trying the third time they put in a new set of teeth; their teeth evidently did not fit tight, so they left the eye of the right tension and ran the saw successfully until this set was worn out.

"The first set being found I put them in, then the old story of the Virginia rail fence was repeated. I took the teeth out and ground the shanks narrower which received the strain, and I used this set of teeth successfully.

"The theory that the plate of an inserted tooth saw is not destroyed by gumming is correct; but the texture of an inserted toothed saw is as costly as that of a solid tooth. My experience is that 1,000,000 feet sawed will necessitate *new teeth*, that is, where the power is good enough to carry 2 to 4″ feed. If one will think this out he will see why where one is successful another is not. As to perforated teeth, I am entirely at loggerheads with them.

"A very little is removed in gumming, but the liability of breaking out in the cut is so great that it destroys their usefulness. I have seen a perforated, inserted tooth saw with four or five teeth in succession broken out. This was done by first breaking off one tooth in a hard cut of oak log.

"The theory of allowing for expansion by perforation does not hold good at all. I have seen these saws flutter and roll the same as any saw warm at the edge."

The Pitch Circle.—Misleading directions are often given concerning the laying out of the face or cutting edge of circular saw teeth. It is frequently stated that the front face should be the tangent of a circle "one-fourth the saw's diameter," if ripping hard wood, or "one-fifth," if soft, when in reality, three-fourths is meant in the first case, and four-fifths in the second. Fig. 320

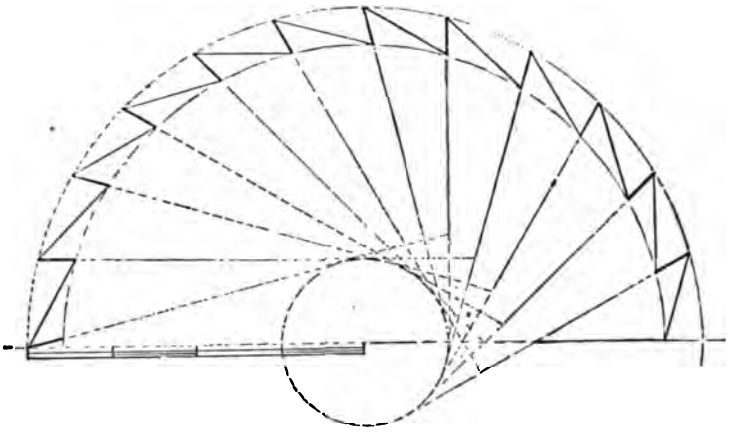


Fig. 320. Showing Tangent Circle 1-4 Saw Diameter.

shows teeth laid out to tangents of a circle one-fourth the disk diameter. It will be seen that this is not a suitable tooth for hard wood.

The Latest "Smallest Circular Saw in the World."—On page 62, Fig. 90, was shown in actual size what was then believed to be the smallest circular saw in the world; its use being to make the slits in gold pens. But a still smaller one has been found,

used for the same purpose by Mr. John Holland of Cincinnati,

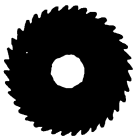


Fig. 321. Smallest Circular Saw in the World.

and given in full size in Fig. 321. It is run from 2500 to 4000 revolutions per minute.

Making Small Circulars for Screw Nicking.—At the works of the Union Screw Works, Cleveland, Ohio (one of the best organized factories we have ever inspected), the small circulars for nicking screw heads are made in a machine designed by the superintendent, Mr. W. H. Bidwell. The blanks are punched out of sheet steel, of size and thickness varying with the screws to be nicked. They are then strung on a mandrel, say 50 on each, and tightly bolted up. Three mandrels are put in a machine which has three shaper heads, each bearing a tool having one edge vertical, and the end ground to 60°. These tools, being mounted with their straight sides a little off the radial line of the disks, travel together, each cutting at one pass one tooth in each of the disks on its mandrel. An index wheel on each mandrel automatically causes partial rotation of the disks at each cut, and insures desired number of teeth, evenly spaced.

Speed of Circular Saws for Barrel and Shingle Work.—John Greenwood & Co., Rochester, N. Y., say: "We can add very little to the valuable information contained in 'Grimshaw on Saws,' except, perhaps, in relation to the gauges given for concave saws on page 67. For barrel-head work, the gauge, if it is the English standard, is three gauges too light. A 7-inch saw should not be more than 15 G., 14 is what we generally use for 7 and 8-inch saws. For 10 inch, 11 and 12 G. We run these saws over 5000 revolutions per minute, and 40-inch shingle saws, 60 teeth screwed to cast-iron stiffening collars, 1300 revolutions. Your tables of speed are rather lower, say 10 per cent., than the rule in our line of trade. We find our customers increase on our figures consid-

erably sometimes. One we know of is running a 42-inch shingle saw in heading 1500 revolutions per minute."

Speeds of Circulars.—The statement that there is a fixed and invariable rule for speeds of saws of given diameter, needs more than a little qualification, as disks of the same diameter take different speeds according to gauge, quality, temper, teeth, timber to be cut, etc.

Concave Saws.—"The temper of a concave saw, in our opinion, ought to be as good and as high as in any ordinary circular doing the same nature of work. The custom has been to leave them much softer to avoid breaking in the hands of the sawmaker, but a soft saw will not hold the set when cutting hard wood heading. The disk is made to a true circle, and in size corresponding with the diameter of the heads they are to circle, providing the heads are cut square on their periphery, as cheese-box heads are made. If we want to make a 17-inch cheese-box head, we use a saw dished to a circle of 17 inches, and for a flour barrel head 17 inches in diameter with bevel, we use a saw dished to a circle of 24 inches. The same saw may be used for making various sizes of heading having bevelled edges by changing the angle of the axis of the head in relation to that of the saw. In that case the bevel on the heading is also changed or altered to suit the saw; in a small head they are sharper and in a large head stunted. Concave saws sawing bevelled heading must be filed like ripping saws, square across the tooth."

Sectional Grooving Saw.—Fig. 322 shows a form of sectional grooving saw in which the action is gradual throughout the width of the cut. As seen by the engravings, it consists of six sections, all alike, and each having four teeth. These six sections, being put on one mandrel, are so arranged that the teeth take up nearly the circumference. In cutting with them, one section cuts out a kerf one-sixth the diameter of the groove intended to be made, and the next one cuts alongside of the kerf that the first one made, etc. By this means the action is much smoother than if there were but one section, each end cutting full

kerf width. This saw is made by Goodell & Waters of Philadelphia.

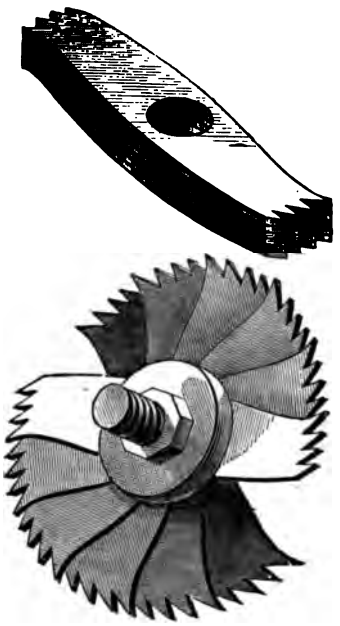


Fig. 322. Sectional Grooving Saw.

Adjustable Veneer Saws.—By making the holes in a veneer saw segment oblong radially, the segment is rendered more easily adjustable.

An Adjustable Dished Circular, patented by S. B. Wells, in 1854, had an angular incision cut from the edge to the centre, or, in other words, a section was cut from the disk, which was then sprung by means of washers and rings to the desired curvature. It was designed for cutting barrel staves, wheel felloes, etc., and intended to be run somewhat slower than the ordinary circular.

Kringer's Insertable Saw Tooth.—In U. S. Patent, No. 248,761, October 25, 1881, Fig. 323, the saw plate *A* has a socket *B* (provided with a shouldered portion *II*, having a depression *I*),

and is also provided with a depression *L*. The saw tooth or bit proper has an oblong, rounded V-shaped projection *J*.

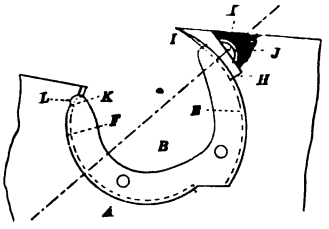


Fig. 323. Kringer Tooth.

Hubbard's Relayed Saw Tooth (U. S. Patent, No. 245,831, August 16, 1881) is for a relayed saw tooth consisting of a body part, having a bevelled edge which extends above the throat, and a hood or removable part bevelled to fit the bevel of the tooth and projecting into the throat below the bevel. The removable part has also a heel projecting into the recess in the throat.

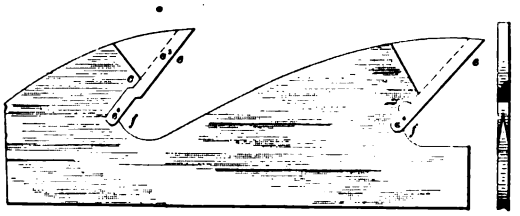


Fig. 324. Hubbard Relayed Tooth.

Mulford's Insertable Saw Tooth (U. S. Patent, No. 236,690, January 18, 1881) is shown in Fig. 325.

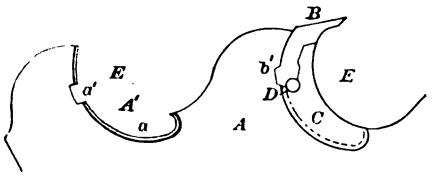


Fig. 325. Mulford Tooth.

Douglas' Insertable Saw Tooth (U. S. Patent, No. 236,876, January 25, 1881, Fig. 326) has a projection on one side longest

in the run of the cut of the tooth from the point backward, on which there is a flat surface parallel with the face of the saw.

Fig. 326. Douglas Tooth.

Hill's Insertable Saw Tooth (U. S. Patent, No. 239,098, March 22, 1881).—The blade *A* has throats or gullets *C*, and its teeth are recessed entirely above the gullets. Those portions of the detachable tooth *B*, which are in the same recess, are of the same thickness of the blade and have a double curved shape.

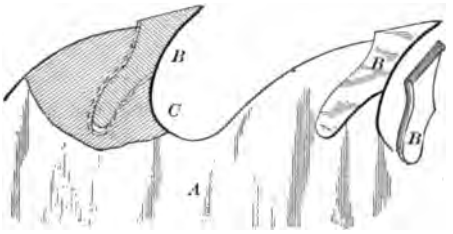


Fig. 327. Hill Tooth.

Atkins' Detachable Saw Tooth (U. S. Patent, No. 246,703, September 6, 1881) has, in combination with an insertable saw tooth having suitable projection, strong locking jaws, forming a recess in the saw plate.

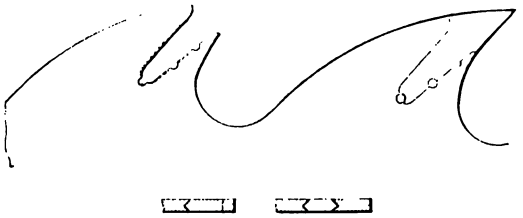


Fig. 328. Atkins Tooth.

Simonds' Loose Circular Saw (U. S. Patent, No. 237,617, February 8, 1881), shown in Fig. 329, is loose with reference to its diameter and also with reference to its radii; but with reference to its diameter, more loose at the eye than any other part.

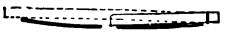


Fig. 329. Simonds' Loose Circular.

Osgood's Side Cutting Circular (U. S. Patent, No. 238,521, March 8, 1881) has side cutting teeth *a a*, and chisel cutting teeth *f f*, the latter being curved as shown in Fig. 330, to under

Fig. 330. Osgood Side Cutting Circular.

cut or to plane out the wood between scores made by the teeth *a a*, the scorers being shorter than the cutters.

Northway's Planing Saw (U. S. Patent, No. 245,090, August 2, 1881).—There are sawing teeth *B* and planing blades *C C*, cut

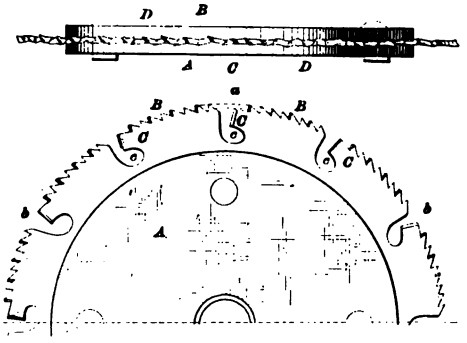


Fig. 331. Northway Planer.

into the working edge of the saw. The points of the teeth *B* extend radially beyond the points of the planing teeth *C C*. The edges of the planing teeth extend laterally alternately in opposite directions, further than the whole remaining portions of the blade. The planing teeth *C* have throats *c* to receive the chips.

McDonald's Saw Arbor (U. S. Patent, No. 243,076, January 21, 1881).—There is an attached collar *c*, having a flat face and round edge *a*, the saw resting against the flat face.

Figs. 332 and 333. McDonald Arbor.

Bennett's Hand Circular Saw (U. S. Patent, No. 239,703, April 6, 1881) has a circular saw projecting below the edge of the plate on which it is mounted, and receiving its motion from one or more friction wheels, which move along the surface of the board to be cut.

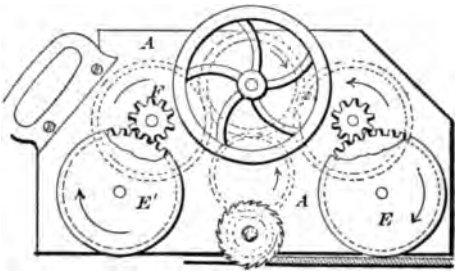


Fig. 334. Bennett Hand Circular.

Suggestions for Making Saw Mandrels, *with special reference to Facing the Saw Collars.*—"First. Special care should be taken to have good drilled centres in the shaft, and when the shaft is turned to see that the mandrel is tight in the lathe centres. Second. Do not chamber out the face of the saw flanges or collars, but finish them so as to give a full bearing on the saw. Third. The face of the loose collar should be perfectly flat; be sure that it is not concaved or full at the centre. Fourth. The face of the fast collar, which is shrunk on or made part of the mandrel, should be faced or made a trifle concaved, so that by laying a perfect straight-edge across it and looking through towards a strong light, daylight will be barely discernible. The last cut should be made with a very fine-edged sharp tool. All cast collars should be of very soft iron and carefully annealed so that they will not contain hard spots. Fifth. The greatest care should be used in fitting the lug or steady pins. They should be made of steel, very carefully turned and fitted, so as not to require force in driving. After they are in, the face of the collar should be very carefully

examined with a straight-edge to ascertain if driving them has not raised and swelled the metal of the collar around them, and if so, it must be very carefully chipped or filed off level with the face of the collar. The above applies to circular saws for saw-mills only. For resawing or for bench saws both collars should be turned concaving."—JAMES E. EMERSON.

Packing Circular Saws.—A custom followed universally in Europe, but not at all in America, is "packing" circular saws with pieces of hard wood, such as mahogany, under the saw table on either side, and lying immediately parallel and close to the disk, which it serves to guide and prevent from wavering. In many cases the packing contains a gasket of felt or similar material, well charged with oil, and serving to lessen not only the friction of the disk against the packing, but that in the cut itself. Mr. Samuel Worssam, in 1853, designed and made a packing by loose blocks on each side of the saw, each fitted with adjustable packing pieces. Abbey, of Paris, "packs" with four adjustable screws above the saw table, their points terminating in hard wood and touching the disk at opposite points. Good packing enables the running of a thinner saw.

Packing Collars with Paper.—Saw makers recommend this, but it is at best a makeshift for a short time. A saw ought not to be forced into position. When it does not run true it should be hammered.

Range.—The saw should be given little, if any, range into the cut. In theory, it should be exactly parallel; but to offset the tendency to throw off on the side cut of a log, it may be ranged in such a line that the saw would strike the head-blocks fifty or sixty feet off, assuming that they are half an inch from the saw. This range in summer time may be reduced to one-half; that is, to one-fourth inch in fifty feet.

The Hinkley Saw Guide.*—Fig. 335 shows a convenient guide for circulars. The arms are fitted in a bored cylinder, and

* Reliance Saw Works, Milwaukee, Wis.

may be turned back out of the way when changing saws, and dropped into position again precisely as before, without touching or altering the adjustment. The lateral adjustment is effected by

Fig. 335. Hinkley's Guide.

a worm and wheel which moves both arms together backward and forward in the bored cylinder without altering the distance between the saw pins. The worm is attached to a rod and hand wheel convenient to the sawyers, either before or behind the disk, to permit adjustment while in motion without danger. The space between the saw pins is regulated by a bolt on the front end of the guide. This device answers for either right or left-hand mills.

The Use of Water on Circular Saws.—Water, properly applied, is to be recommended, being a good lubricant, and cooling in its effects. It may be used in such small quantities as not to be detected. It should not show on the saw nor be perceptible in the dust. It is employed in some mills in such a manner as to have it fly all over the place. Used in this latter way, it is very objectionable.

The McDonough Hollow Arbor (Fig. 336), an important patent, concerning which there has been much litigation, is based upon the idea of taking water through the mandrel of a circular and having it escape at the collar on both sides of the saw while

in motion, the centrifugal force distributing it equally all over the disk, thus lubricating the saw and keeping it and the journal cool. A jet of water is also discharged beneath the guides to cool that circle of the disk.

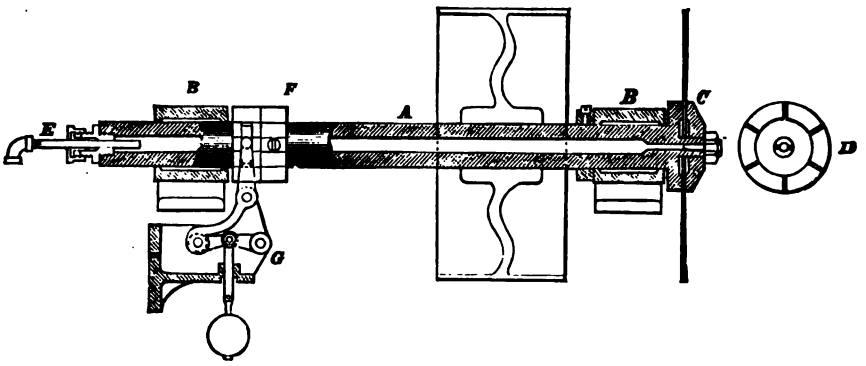


Fig. 336. McDonough's Hollow Arbor.

We understand that the patent has been decided in favor of Mr. F. McDonough, of Eau Claire, and we quote almost verbatim from the circular of the manufacturers, the Reliance Works, Milwaukee, Wis.

"Referring to the cut: *A* is the hollow arbor and pulley; *B B* are the arbor boxes; *C* the saw and collars; *D* the face of collar, showing the small creases through which the water is ejected to lubricate the saw; *E* is the pipe and stuffing-box for the admission of water into the arbor; *F* the tight collar or shoulder on the arbor; *G* is the weighted saw relief and collar, which can be attached conveniently to the husk.

"One patent covers a hollow arbor with water passing in at the tail end, and coming out between the saw collars, vent being given at this point by forming small creases in the face of both collars, so that water is ejected on both sides of the saw, and also by means of small outlets acting as lubricators for the boxes. The great value claimed for this over the solid arbor is—

"First. That fifteen per cent. more lumber can be cut, for full feed can be carried on all kinds of logs, no time being lost in waiting for the saw to cool off.

"Second. The same amount of lumber can be cut with ten per

cent. less power, because a much thinner saw can be run, and with much less friction, as the plate is lubricated with water where it rubs on the log.

"Third. It will save ten per cent. in saw scarf, on account of using a thinner saw. The saw can be heavier at the eye, where strength and stiffness are required, and, if necessary, it can be of the same thickness as the scarf.

"Fourth. A great saving in repairs and expense of running, for, if the log rubs on the centre of the saw, it will not affect it, and the arbor will run with one-quarter the amount of oil.

"With this device there is an equal expansion of arbor and plate, avoiding all danger of warping, as the water is run through the *centre* of the arbor, and distributed equally on both sides of the centre of the saw, whence, by centrifugal force, it is evenly distributed over the entire surface of the plate, which is not the case where the water is applied to one side of the saw by means of a pipe.

"Old arbors may be bored to apply this principle."

The McDonough Saw Relief.—The object of this device is to allow lateral motion to the arbor. There is often a tendency for a log to crowd and bind the saw, which, if held perfectly rigid, would heat and probably break. In such case the relief, by allowing end play to the arbor, relieves the centre of the saw from pressure, and the blade, adjusting itself in line with the cut, passes through the log without trouble or damage, and the guide, by holding the cutting edge of the saw firmly in place, insures lumber of even thickness. When there is no crowding of the log, the saw and arbor run perfectly free, as there is no pressure whatever given by the relief, but the moment binding and crowding occur, then it acts instantly and surely.

Opening Wheel.—To lessen the friction of a ripping circular saw in the kerf and to increase the rate of feed, wedges were once driven into the cut, close behind the disk, to separate the several surfaces, but at times this caused splitting of the cant, and to obviate this, G. L. Molesworth devised in 1856 a self-acting revolving wedge, so placed as to separate the two parts and be revolved by its own friction against the sides of the kerf. This wheel,

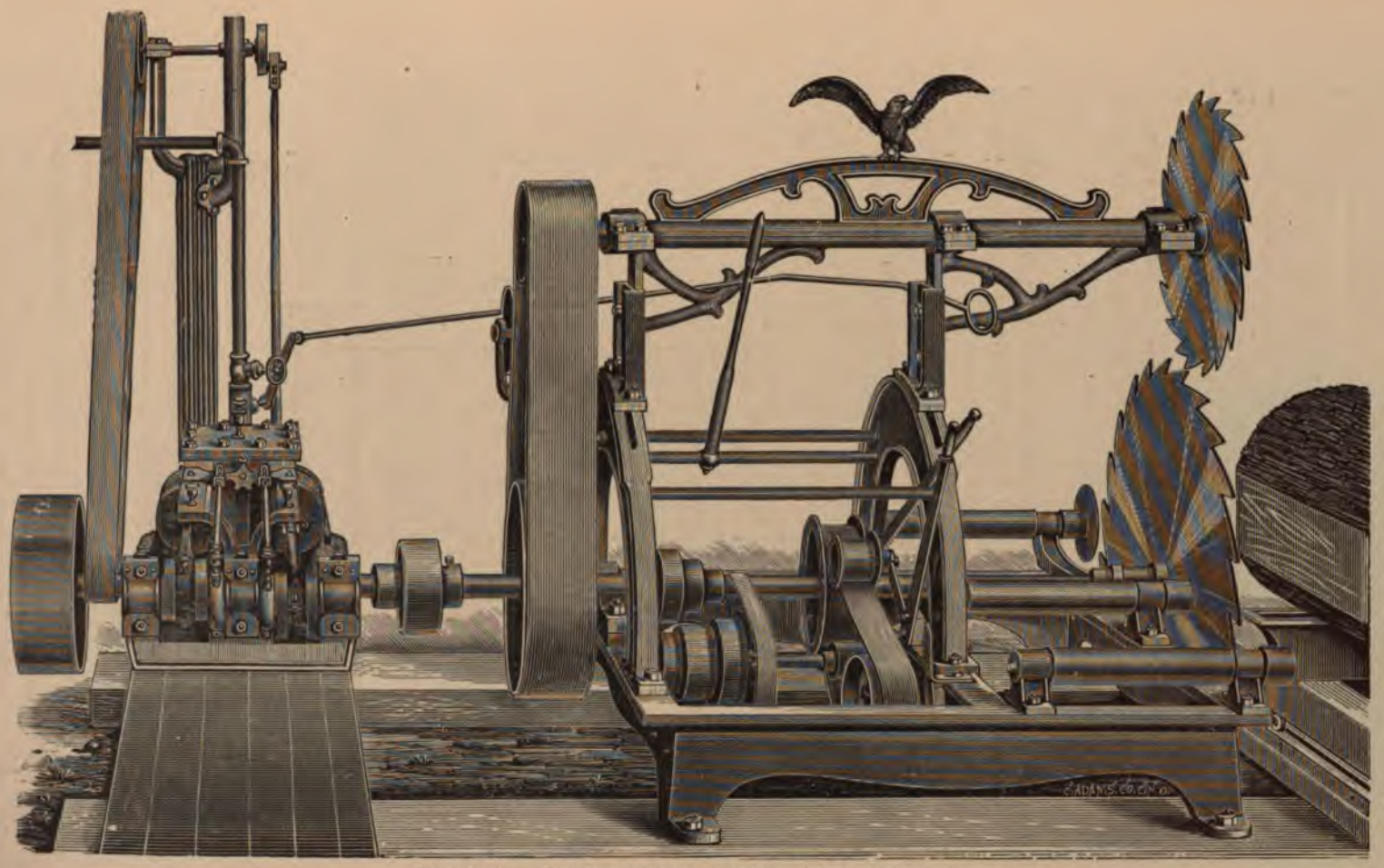


Fig. 337. Double Circular Mill,—Direct Driven.

which now has very general application, exerts a uniform pressure in relieving the saw, and adapts itself to irregular as well as straight sawing.

Direct Driven Circulars.—Fig. 337 shows the double circular saw-mill of Frey, Schechler & Hoover, Bucyrus, Ohio, driven direct from a high-speed engine of special design.

"Three High" Circular Saw.—We illustrate herewith, by courtesy of Tatum, Bowen & Co., San Francisco, in front and side

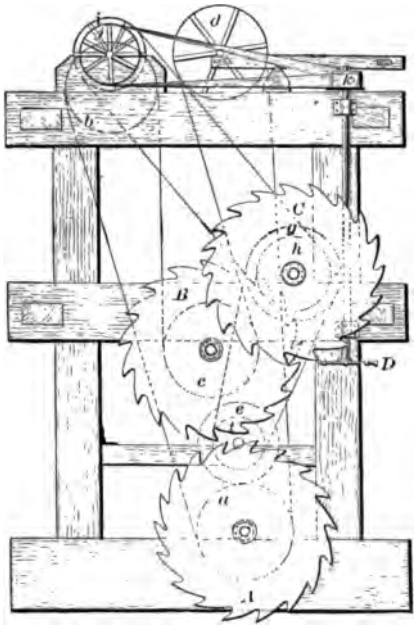


Fig. 338. "Three High" Circular Saw.

elevation, the machine used in California to cut logs ten feet in diameter, and referred to on page 56.

The invention consists in so arranging a gang of saws on the frame, and providing a small horizontal saw to follow or precede the gang, that the small saw will rabbet out a place to allow the end of the arbor or collar of the centre saw to pass. There are three vertical circular saws, arranged on the frame in the usual

way for double circular saws, except that the upper one is extended beyond the vertical plane of the lower saws. There is also a vertical spindle, the lower end of which is provided with a small

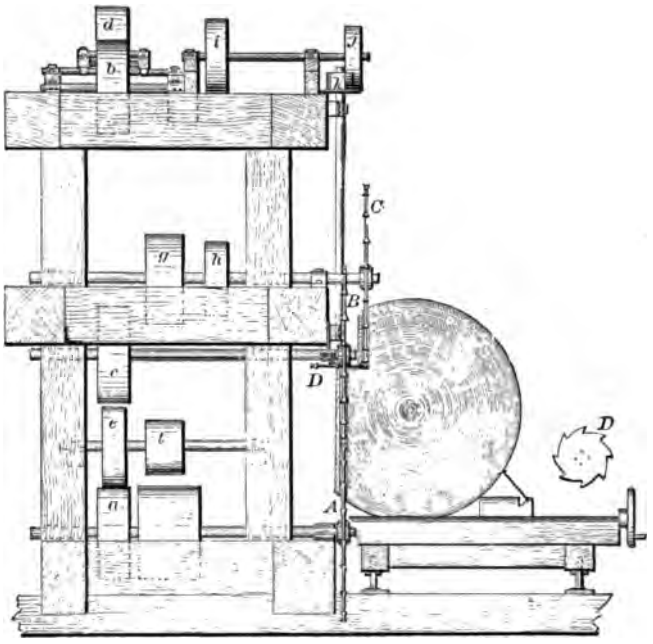


Fig. 339. "Three High" Circular Saw.

horizontal saw which precedes or follows the gang on the plane with the cutting edge of the top saw, on the collar or arbor of the middle or vertical saw. This, when in operation, rabbets out a longitudinal piece along the edge or joint. The upper saw thus cuts a board down from the upper part, while the two lower saws of the gang cut their width. The relative position of the gang is such that the upper face of the log is just as much in advance of the lower log face as the upper saw is in advance of the lower saw, and the distance between the vertical planes of the upper and lower saws is equal to the thickness of the lower saw divided by two and added to the thickness of the board or cut, the projection of the arbor or collar of the middle saw, and the clearance. The clearance may be operated without affecting the operation and perfect working of the gang. When the greatest depth is

obtained, the lower cut or board will be the greater, and the upper one the lesser in width. In operating with such a saw-mill, at first the lower saws of the gang slab one side of the log, and the upper saw is not engaged; but as the set advances the upper saw cuts but little depth, and the horizontal saw following or preceding cuts lengthwise, and a small angular piece of the log is taken off with wane top.

Pitch of Circular Saw Teeth.—"The under side should stand at an angle of 45° to the plane of the cut, as this is the dividing line between a scraping and a direct downward cut. Of course this changes as to height of cut in circular saws."

Broken Teeth.—When a tooth is broken out of a circular saw, it often chops or breaks the timber badly. In fact, when the logs are frozen hard, it is almost impossible to run. To send the saw off to be cut down would seriously lessen its value by decreasing its size. The trouble may be remedied in another manner. As the tooth next behind the one broken has double work to do, it will spread off to one side more than to another, if bent for set, thus causing the extra mark on the timber. Shorten this tooth, whether spring or spread for set, so as to divide the cut. If bent for set, file the tooth next behind the one broken square across the blade, swage it out to full set, both sides alike. The saw will then cut as nicely as before, and will make but little mark on the lumber. If the saw be swaged for set, file the tooth on the top so as to divide the cut, and reduce the set a little in this tooth, using great care not to file it too much.

Sheared Teeth.—A tooth "sheared" or filed to a bevel of say 5° to 20° will do the work with less power (provided the tooth is strong enough otherwise to resist the tendency to spread in the cut). If a person were to take a jack-knife to cut a stick of any size, he would turn his knife to about that angle with the grain. A "sheared" tooth is in better shape to enter the wood than if swaged square. In Vermont, they swage the point about one-half the set and bend the rest, and shear 5° to 10°.

Rounding.—By holding an old file firmly to the edge of the saw when at full speed, marking the teeth on the points, then filing off the backs until the marking disappears, looking closely so as

not to file a particle more than to the line, the saw may be rounded perfectly. The saw should be rounded on the arbor on which it runs when at work, although this is very seldom done. One sawyer says that he has seen a saw, which seemed perfectly round on the filing mandrel, show $\frac{1}{32}$ inch out when changed to working arbor. This is enough out to make the saw run badly in some timber.

Jointer for Circular Saws.—Fig. 340 shows an emery grinding machine for circular saws,* which, after gulleting the teeth, facing and backing them, with the emery wheel shown in the

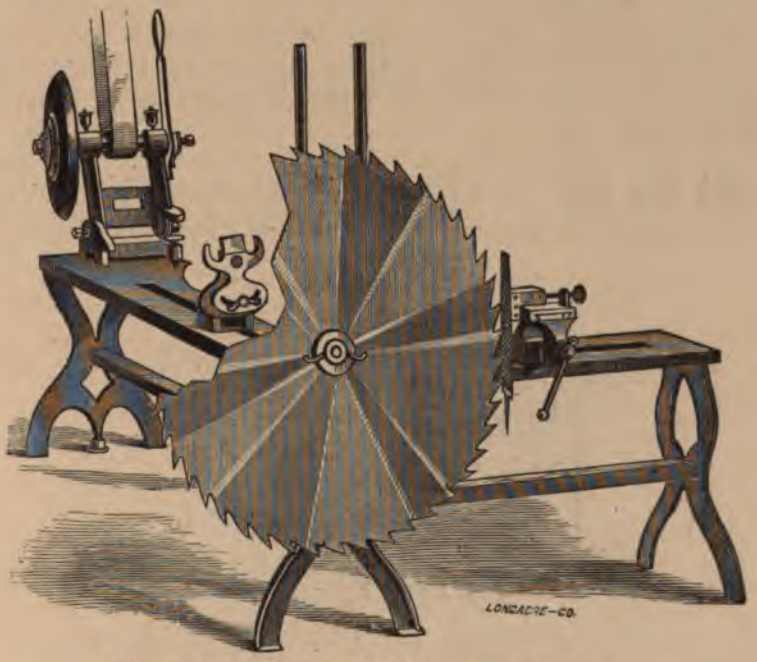


Fig. 340. Jointer and Emery Gummer.

swinging rest to the left of the cut, will "joint" them on an ordinary flat file held in the vise at the right: thus insuring that all the teeth are of the same length; or, rather, that the tips are all in the same circle, concentric with the mandrel.

* E. Andrews, Williamsport, Pa.

M Toothed Circular.—Boynton makes an M tooth circular saw which we suppose he designs to be reversible, being finished on both sides and turned on the mandrel when one set of teeth grows dull. This may or may not be an advantage for small disks. It is intended for both ripping and crossing.

The Spiral Saw.—A special class of saw, of which we know but one variety, is Armstrong's spiral saw used for making dovetails. In action it comes in between the band and the circular segment saws. The segments are clamped in a spiral groove in a holder having eccentric rotation. Those making the first cut have a straight edge; those at the last of the cut have their cutting edge at right angle to the plate; the intermediate ones grading between these extremes. As the cutting flange of each segment is worn away by filing, it is moved on one space towards the unflanged end.

The Rim Saw is a connecting link between the circular and the band saw; being simply a flat ring—not a belt—toothed upon

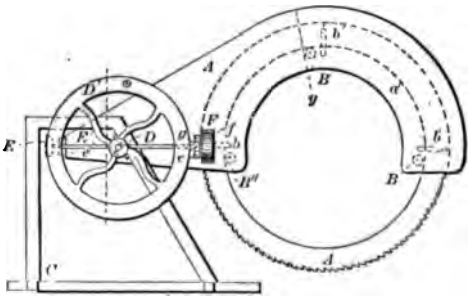


Fig. 341. Rim Saw.

its outer edge. It is fed by friction rollers. Fig. 341 shows one (U. S. Patent, 252,268) driven by suitable mechanism.

Amesbury's Spiral Band Saw File.*—This machine is fastened to an ordinary bench. The saw is hung over it (if the work is not done while the saw is in place). The file is in two sections—one stationary, the other movable in the direction of the axis. The stationary section carries the feeder and a thin segmental file, which

* G. W. Amesbury & Co., Philadelphia.

latter files only the throats and faces. The movable section carries a thick bevelled file variable for varying grades of teeth. It rotates on a higher plane and files the tooth-backs, also taking the burr from the points. The thumb-screw *D* varies the height of this section to suit the grade of teeth and to change the pressure. The thin face and throat file is cut only on its face and corner. The filing head runs in an oblong bearing so that it can move to allow for high teeth. There is an adjustable pressure spring *E*, which holds it to the work; and there is another spring under the head, keeping it to the tooth face—thus giving the high teeth the most pressure and bringing them down to the general level. The saw is held in a clamping jaw with the back resting against the gauge *F*, which is adjustable to any saw width by the screw *C*, and can be set at any angle. The clamping jaw is operated by a cam on the hub of the gear, and opens and closes as the machine is feeding or filing. This jaw acts like a vise upon the saw when the files are in contact with the teeth, and releases it when in contact with the feeder.

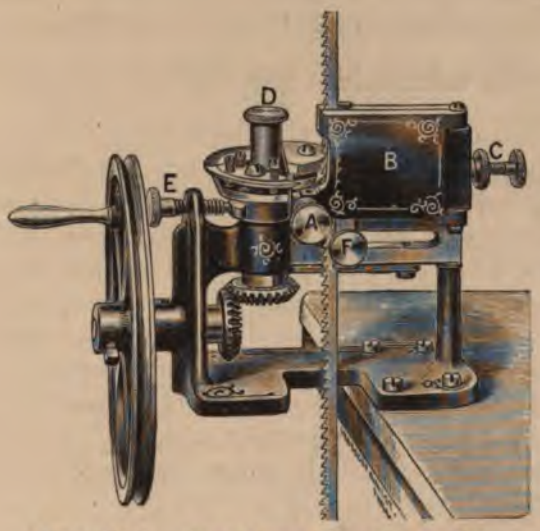


Fig. 342. Amesbury Band Saw File.

The machine has a capacity for saws $\frac{1}{16}$ to 2 inches wide, and from the finest tooth to two teeth to the inch. It is driven by hand or power, as desired, and is claimed to file saws of 500 to 1800 teeth in 30 to 90 minutes.

BAND SAWS.

Early Band Sawing Machines.—A band sawing machine was patented in France in 1815 by Toroude, and another in England in 1845 by Thouard. But it was not until 1855 that the machine was rendered practical and efficient; this by Perin of Paris. Parienté followed at once with an English patent, and in 1856 Exall and Barbour took out one. In 1866 Wilson patented a combined band and jig, the object of which was to cut the outside curves with the constantly running band, using the jig for the inside cutting.

The Original Newberry Band Saw of 1808 (see p. 83) had in some cases no teeth, being a blade for splitting skins.

A Reciprocating Band Saw was patented in England in 1879 by Adam Knox of Glasgow. The blades are horizontal, and reciprocated either on the rim of segmental levers or on pulleys. The machinery proposed is very complicated.

A Multiple Band Saw was patented in England in 1876 by Johnstone.

Circular vs. Band.—One point in which the circular has the advantage over the band is that the former has much the faster feed and will turn out a greater quantity of work. No doubt the circular will be very largely used until lumber becomes so valuable that sawyers find it economical to save lumber which they are now wasting in sawdust. This is now occurring in valuable lumber, such as black walnut, mahogany, and various classes of imported woods, and where these are being sawed into thin material, the band log saw is especially called for. Fay & Co. in their large band saw use a No. 18 gauge blade, which takes out about $\frac{1}{16}'''$ kerf.

Band vs. Mulay.—We quote below the opinion of a prominent New York manufacturer of wood-working machinery, concerning the Band Saw vs. the Mulay and Circular: "The circular does say one-third more work than the band, but with greater

waste; its kerf for large saws (cutting 24″ to 30″ wide) being as much as or even more than $\frac{3}{16}$″; while the band saw on the same saw would not take more than about $\frac{3}{32}$″. The band resawing machine will therefore effect a large saving in costly timber and in making thin stuff where the kerf is a large percentage of the whole. Properly handled, a band resawing machine will cut as thin as $\frac{1}{8}$″ 24″ wide, making a kerf $\frac{1}{16}$″ full. Segmental circular saws riveted to and backed by large plates can be made to do equally well, but they are then unfit for anything but taking off a thin piece which can be sprung out by the plate without binding or heating the saw.

"The mulay will not do more than about one-third as much work as the band saw, and will make a kerf of from about $\frac{1}{32}$″ to say $\frac{1}{8}$″.

"The band saw labors under the disadvantage that there are at present but few men in the country who thoroughly understand setting up and using it. But even when properly handled it cannot successfully compete with the circular saw for log sawing, although superior to the mulay, which it excels both in speed and economy; this for the reason that in such work speed more than economy of timber is sought."

One Disadvantage of Circular and Band Saws is that although the cutting is continuous the feed is intermittent, and in board work the log must have several passes if wide. In this the gang sash has the advantage of all others—the cant passing through but once.

Band Saws for Bevelled Work.—Cabinet-makers and chair-makers are among those who require large quantities of *bevel* sawing and need band saws, having once availed themselves of the dished circular.

Thin Band Saw Blades stand better than thick ones, owing to their superior pliability.

"Band Saws for Metal Cutting should be rigidly held, and have a lineal velocity of 250 feet per minute. The teeth should be finely spaced and of 60° crosscut shape."

Band Log Sawing.—From a personal letter to the author from Mr. J. R. Hoffman, dated December 26, 1879, we make the following excerpts: "The main obstacle that I met with in starting the band saw for log sawing was in obtaining the saw blade. I tried for fifteen years to persuade some manufacturers to make a saw, and after the first introduction of the small band saw in this country, I returned to the charge and exhausted the patience of a great many saw manufacturers by my importunities, and should have continued to harass them until the present time had not a firm in France taken the order and furnished us with saws. During the French and German war we succeeded in getting a few saws made in this country in short pieces, and since that some manufacturers have succeeded very well in their manufacture. Still we prefer imported stock.

"There is no romance about this thing; it is intensely practical. No starving wife or ill-fed children with quivering lip and transparent skin sat at the low hearth-stone while it was being worked out. They knew nothing of it. I wanted it. Like the boy with the gopher, 'I had to have it.' I could not afford to waste so much lumber. I set to work and made it. I wanted to use it and have used it to some purpose; if others cannot see the advantages, more the pity—for them."

Bevel of Band Saw Joints.—In joining band saw blades, one rule for the amount of bevel is to give a bevel on each side of the joint as long as the distance between two teeth.

Brazing Band Saw Blades.—"Muriatic acid," also called "hydrochloric" and "chlorohydric" acid, is used as a flux. The joint should be finished by filing lengthwise of the blade.

Files for Band Saws should have their edges rounded, as shown in Fig. 345, to give rounded gullets and avoid cracks.

Rounding Band Saw Gullets.—A rat-tail file may be used to round band-saw gullets, where rounded three-cornered files are not obtainable.

A Serrated Steel Disk for Band Saw Sharpening was shown at the Paris Exposition of 1878, by Martinier, the inventor. The machine in which it ran gave an automatic feed to the blade.

An Inclined Blade Band Saw for bevel sawing is shown in Fig. 343.

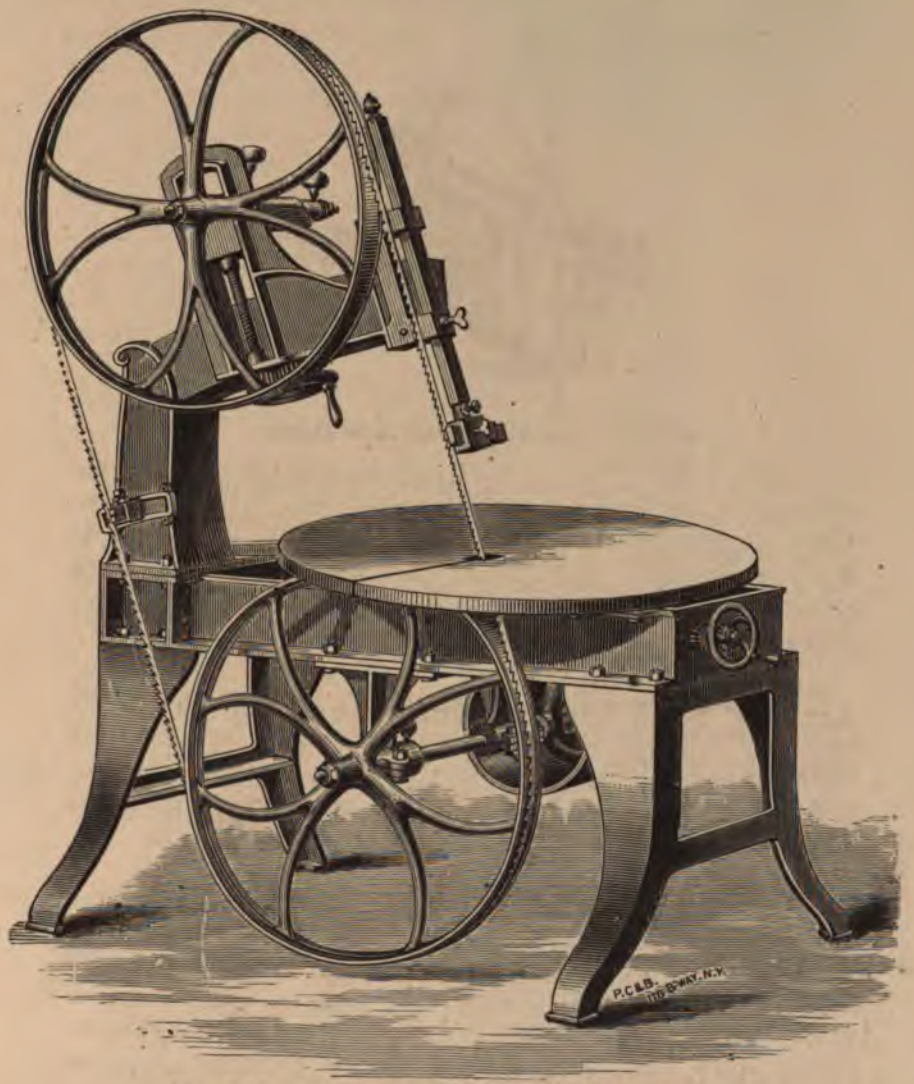


Fig. 343. Pryibil's Inclined Blade Band Saw.

A Band-Saw Guide, shown at Paris in 1878 by Quétel Tré mois, consisted of three hollow brass blocks filled with oil and perforated on one side, which were pressed against the blade in such a manner as to both steady and lubricate it.

Pryibil's Band Saw Guide, shown in Fig. 344, consists of two steel blocks adjustable by means of a screw to any thickness of

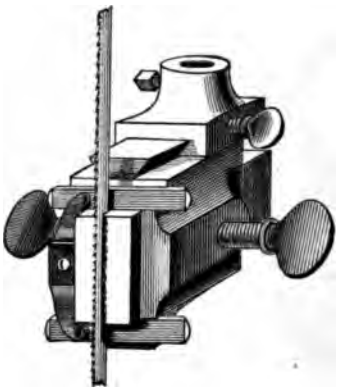


Fig. 344. Pryibil's Band Saw Guide.

blade, and in depth from $\frac{1}{16}$ to $1\frac{1}{4}$ inches. The back of the blade runs against two hardened steel slips which are adjustable lengthwise to change the line of contact when grooving commences. It is adjustable on the guide-post at any height, to suit any height of stuff; of course being kept as near as possible to the top of the stuff sawed.

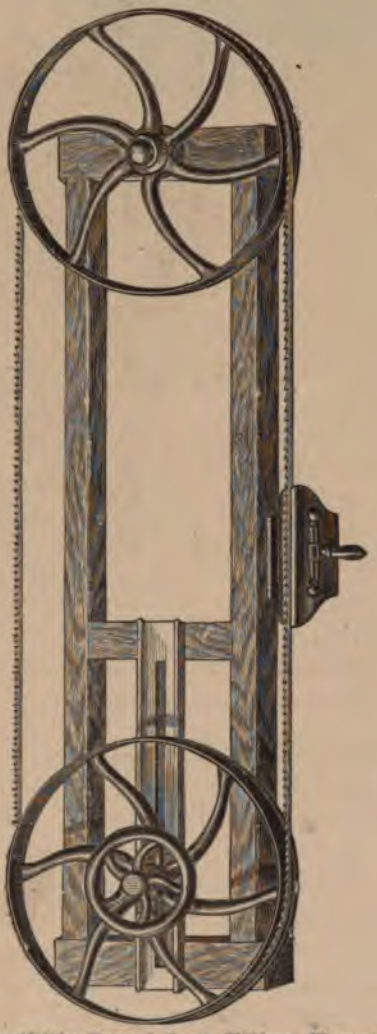
The Band Saw Filing Apparatus, shown in Fig. 346,* consists of a frame bearing two wheels over which the band is placed —their distance apart being adjustable. Between them is a filing vise or clamp 20″ long, worked by three eccentrics and a handle. The vise may be used for jig as well as for band saw blades.

Pryibil's Band Saw Setter (Fig. 347).—"The hand wheel spindle carries a crank operating through a connecting rod upon two vertical slides, one on each side of the saw. These slides are provided with adjustable cam faces (front adjusting screw shown at *a*) acting through friction rolls upon the setting levers. This adjustment after being once set never needs to be altered except to take up wear. Adjustments for different gauges of saws are made by means of the screw *b*. The saw is guided between the faces *c* and *d*; the teeth bearing against the faces *c* of the hinged frame

* Made by P. Pryibil, 461 W. 40th St., New York.

c' vertically adjustable through the thumb-screw e, the back bearing on the faces d attached to the rods f, and forced upward by the

Fig. 345. ***Fig. 346.***



Band Saw File. ***Pryibil's Band Saw Filing Frame.***

springs g, the tension of which is regulated by a thumb-screw (not shown) acting on the yoke h. Through the hinged frame c' the height of the saw relatively to the setting tools is governed

and thereby the set regulated, variations in width of saw affecting only the faces *d*, and therefore not the set. The band is fed two teeth per stroke by the pawl *i* connected by a spring to the lever *k*, taking its motion from the connecting-rod above men-

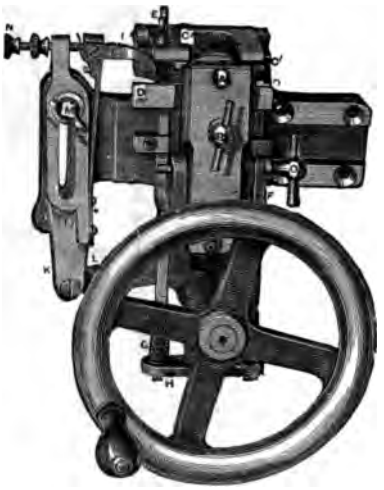


Fig. 347. Prybil's Band Saw Setter.

tioned through the link *b*. The stroke of the pawl is regulated by moving the fulcrum *m* of the lever *k* in the slot. By means of the adjusting screw *n* the teeth of the saw are, after other adjustments have been made, brought opposite the setting tools."

Atlantic Works' Band Saw Setting Machine and Filing Frame (Fig. 348).—The filing frame is of iron pipe with suitable cast connections and cross pieces. Attached to it is a sliding carriage bearing an oscillating set hammer. The feed is automatic, and adjustable to any tooth pitch. Two teeth should be fed forward at each stroke of the set hammer. The saw is strained and passes between two steel blocks or anvils. The teeth are brought to the proper height on the anvils by putting under the saw a strip of metal thicker than the blade. The stroke of each hammer is regulated by a set screw.

Setting Band Saw Teeth.—"Band saw teeth should be set by sudden blows given from the inside of the curve, so that the blade has no tendency to destroy the tire covering nor to run unsteadily."

Fig. 348. Atlantic Works Band Saw Filing and Setting Frame.

Howe's Band Filing and Setting Machine.*—This machine runs by power and is automatic. It uses an ordinary file. The pulley wheel below gives a rising and falling motion to the rim frame bearing the file, while the saw is passed along one tooth at a time by suitable feed gear, difficult to describe without a lettered cut, but which may be studied out in Fig. 349.

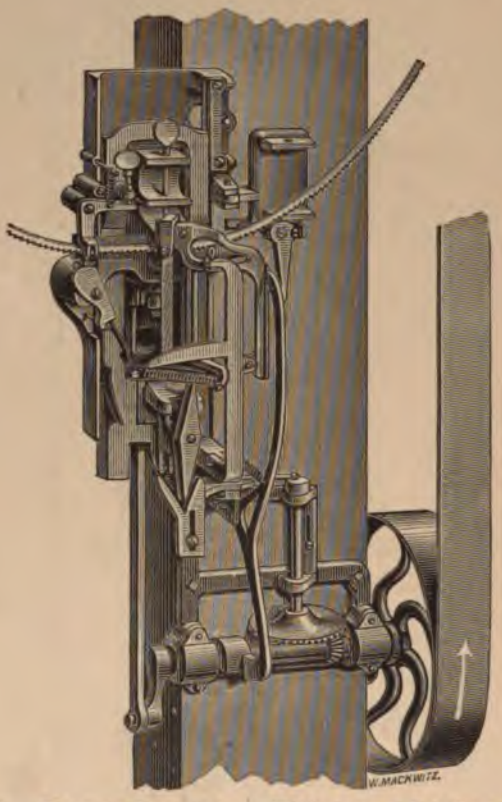


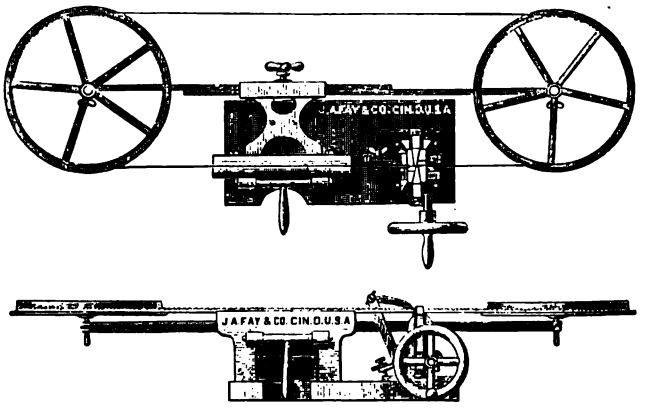
Fig. 349. Howe's Band Saw Filing and Setting Machine.

The inventor states that the machine is 17½ inches high, and 14 inches wide, weighing 50 lbs. "It is run at 75 rotations per minute; files and sets saws $\frac{3}{16}''$ to $12\frac{1}{2}''$ wide, any number of teeth and any length of blade. As regards the power required, no definite tests have been made; but a 1″ belt on a 10″ pulley (only so

* M. Stewart & Bros., 1218 Mallinckrodt St., St. Louis, Mo.

tight that it can be put on with ease without being in motion) will run it; or it can be worked with a crank of 8″ sweep by a ten-year old boy with very little effort. A larger machine is building at the date of writing (April 16, 1882), to file and set saws up to 6″ wide."

The Band Saw Setting Machine shown in Figs. 350 and 351 in top and side view, has proper pulleys and tension device to sus-



Figs. 350 and 351. Band Saw Setting Machine.

tain the saw and keep it at a proper tension while being filed and set. For filing there is a suitable vise. The setting is accomplished by two hammers driven by a cam on a shaft revolving on a hand wheel.

MISCELLANEOUS.

Scandinavian Floors.—The chamber floors found in the northern parts of Sweden and Norway are laid with boards cut from the tree without being sawn parallel, and consequently retaining all the taper of the tree. The edges of the boards are tongued and grooved, and the joiners who cut the tongues and grooves, work in pairs, one pulling and the other propelling the tool that does the work. In consequence of the boards tapering, they are laid with a broad and narrow end meeting alternately, and thus a dovetail is effected along the whole length of the boards, and a very curious appearance is the result.—*Timber Trades Journal.*

The First Saw-Mills in England.—The old practice in making boards was to split up the log with wedges, and, inconvenient as the practice was, it was no easy matter to persuade the world that the thing could be done in any better way. Saw-mills were first used in Europe in the fifteenth century, but so late as 1555, an English ambassador, having seen a saw-mill in France, thought it a novelty which deserved particular description. It is amusing to note how the aversion to labor-saving machinery has always agitated England. The first saw-mill was established by a Dutchman, in 1663; but the public outcry against the new-fangled machine was so violent, that the proprietor was forced to decamp with greater expedition than ever did Dutchman before. The evil was thus kept out of England for several years, or rather generations, but in 1768, an unlucky timber merchant, hoping that after so long a time the public would be less watchful of its own interests, made a rash attempt to construct another mill. The guardians of the public welfare, however, were on the alert, and a conscientious mob at once collected, and pulled the mill to pieces. —*The Iron Age.*

Correcting Unequal Tension in Circular Saws.—U. S. Patent, No. 237,915, to Geo. F. Simonds (February 15, 1881), is for a method of correcting unequal tension in circulars by clamping them between heated disks held in formers of ordinary temperature; the formers also clamping the saw around the outside of the disk. In the cut, *A A* are formers and *B B* heated disks.

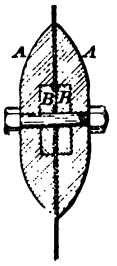


Fig. 352.

Adjusting the Tension of Circular Saws: Simonds' Method.—U. S. Patent, No. 239,863 (April 5, 1881) is for pass-

Fig. 353. Adjusting Tension.

ing a graduated gauge between the straight edge and the bent saw.

Quick Saw Making.—November 11, 1875, Emerson, Ford & Co. (now Emerson, Smith & Co.), of Beaver Falls, Pa., made a 40-tooth solid saw 60 inches in diameter, gauges 5 and 6 inches in 7 hours 45 minutes of work. The anvil work, flattening, smithing, hammering, and blocking took 4 hours 55 minutes, there being given 12,764 hammer strokes. The smithing took 8523 of these blows. The drilling, toothing, grinding, hardening, tempering, and cooling took 2 hours 50 minutes.

Mending a Broken Arbor.—"I will tell you how I mended a broken saw arbor with only blacksmith's tools. It is a circular wood-saw. The screw on the saw end, 1″ diameter, broke off at the shoulder, which latter, being but 1¼″ diameter, I considered would weaken it too much to drill and tap in a screw large enough to be safe; besides, trouble, time, and expense of sending to shop. So I squared ends, and centred nicely, and drilled ½″ hole in each piece 1″, and joined them with a dowel. I roughened the dowel a little with a screw-die to make brass flow well, and wound the neck with fine iron wire to hold melted brass and make sure of a

strong job. Drilled vent-holes near ends of dowel, then put it in the fire and brazed the joint, and it proves an entire success. It has since been accidentally subjected to a most violent test, so that I believe it now just as strong as before broken."—C. G. OSGOOD, Foristell, St. Charles County, Mo.

An Old Saw Anvil.—Fig. 354 shows a relic exhibited at the Centennial Exhibition, Philadelphia, 1876, by Mr. E. Andrews, saw maker, of Williamsport, Pa. It is interesting to note the continuance of a handicraft for so long in one family.

This Anvil was the first Saw Makers' Anvil brought to this Country. It has been used and owned by an Andrews for over seventy years, and was brought from London in year 1819, by Wm. Andrews, Uncle of the present owner.

Fig. 354.

Sawed Veneers.—Sawed veneers preserve the natural color and grain of the wood better than sliced.

Materials having a Granular Nature must be divided by sawing, while those which are fibrous can be divided by direct cutting. Wood partaking of both granular and fibrous nature, is divided by sawing or cutting, as the grain may determine.

In Sawing Stone the edge of the blade is rounding and used with a rocking motion, so as to make it "take in" deeply first in one place then in another, rather than uniformly all along the cut.

Shingle Saws should be tapering to 14 gauge.

A Decimal Gauge for Sheet Metal and Wire.—Gauges, or notched plates for measuring thicknesses of metal sheets and wire, were at first of local origin and innumerable variety. One of the Birmingham gauges (the Stubs) has been most carefully perpetuated. In America one was introduced by Brown & Sharpe, to correct some discrepant proportions in this last, by establishing a regular proportion of the 39 successive steps between 0000 and 36. Starting at 0.46 inch for 0000, each gauge is 10.9478 per cent. less than the preceding one; giving 0.005 inch for No. 36, which is 35 of the Birmingham.

The great use of the gauge to-day is for purposes of estimate—calculating the value of given superficies or lengths in weight of material, or *vice versâ;* and any notation or division of parts facilitating this would be an advantage. The proposed Decimal Gauge, which we owe to the eminent engineer, Mr. Robert Briggs, is based on the successive reduction of an assumed unit of dimension, by $\frac{1}{10}$; or, what is the same thing, successive increase by $\frac{1}{9}$. The centimetre = 0.3937079 inch, is zero.

Table I. gives a comparison of the Decimal, the Birmingham, and the American gauges. The diagram shows the irregularities of the Birmingham and its comparison with the other two.

The solid volume of a sheet one metre square and one millimetre thick, is a cubic decimetre, or a litre, or a kilogram of water. The weight of a plate of any gauge is simply found from the specific gravity of the material. Thus as the specific gravity of iron is 7.7, a square metre of iron, one mm. thick, weighs 7.7 kilograms; and if a centimetre thick, 77.7 kilograms, etc.

This gauge will give a scale of proportionate dimensions for all practical sizes and thicknesses of that metal, and diameter of wire. The scale is capable of indefinite extension at either end. It gives a numerical proportion easily remembered and readily used in computation. In sheet metal, especially where it is a constant requirement to estimate for weights, it would be a great advantage after having laboriously calculated the weight of a vessel, tank, boiler, or caldron, for some assumed thickness, to be able to increase or lessen the weight without figuring anew. To weigh 10 per cent. less, then a gauge off the thickness does it.

TABLE I.

COMPARISON OF DECIMAL, BIRMINGHAM, & AMERICAN WIRE GAUGES.

DIMENSIONS IN ENGLISH INCHES WITH CORRESPONDING DIMENSIONS FOR DECIMAL GAUGE IN CENTIMETRES.

No. of Gauge.	Decimal Gauge. Centimetres.	Decimal Gauge. Inches.	Birmingham Gauge. Inches.	Amer. Gauge. Inches.
0000 = —3	1·3717	0·5401	0·454	0·46
000 = —2	1·2346	0·4861	0·425	0·4096
00 = —1	1·1111	0·4375	0·38	0·3649
0 = 0	1·	0·3937	0·34	0·3249
1	0·9	0·3543	0·3	0·2893
2	0·81	0·3189	0·284	0·2576
3	0·729	0·2870	0·259	0·2942
4	0·6561	0·2583	0·238	0·2043
5	0·5905	0·2324	0·22	0·1819
6	0·5314	0·2092	0·203	0·1620
7	0·4883	0·1883	0·18	0·1443
8	0.4305	0·1695	0·165	0·1285
9	0·3874	0·1525	0·148	0·1144
10	0·3487	0·1373	0·134	0·1019
11	0·8138	0·1236	0·12	0·09074
12	0·2824	0·1112	0·109	0·08081
13	0·2542	0·10008	0·095	0·07196
14	0·2288	0·09007	0·083	0·06408
15	0·2059	0·08106	0·072	0·05707
16	0·1853	0·07296	0·065	0·05082
17	0·1668	0·06566	0·058	0·04526
18	0·1501	0·05309	0·049	0·04030
19	0·1351	0·05318	0·042	0·03589
20	0·1216	0·04787	0·035	0·03196
21	0·1094	0·04307	0·032	0·02846
22	0·09848	0·03877	0·028	0·02535
23	0·08863	0·03489	0·025	0·02257
24	0·07977	0·03140	0·02	0·02010
25	0·07179	0·02864	0·018	0·01790
26	0·06461	0·02544	0·016	0·01594
27	0·05815	0·02289	0·014	0·01419
28	0·05233	0·02060	0·013	0·01264
29	0·04710	0·01854	0·012	0·01126
30	0·04239	0·01669	0·010	0·01003
31	0·03815	0·01502	0·009	0·008928
32	0·03434	0·01351	0·008	0·007950
33	0·03090	0·01217	0·007	0·007080
34	0·02781	0·01095	0·005	0·006304
35	0·02503	0·009856	0·004	0·005614
36	0·02253	0·008870		0·005000
37	0·02028	0·007983		0·004453
38	0·01825	0·007185		0·003965
39	0·01642	0·006466		0·003531
40	0·01478	0·005819		0·003144

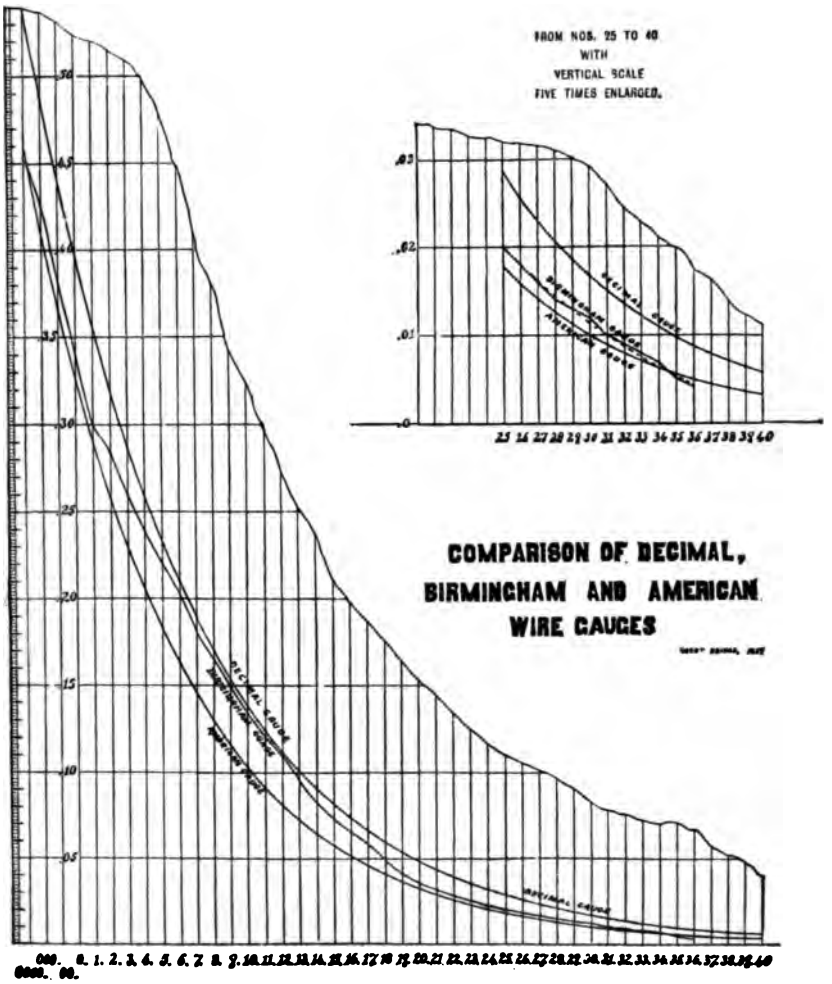

FROM NOS. 25 TO 40
WITH
VERTICAL SCALE
FIVE TIMES ENLARGED.
COMPARISON OF DECIMAL,
BIRMINGHAM AND AMERICAN
WIRE GAUGES

TABLE II.

WEIGHT OF ONE SQUARE FOOT OF SHEET METAL, OR ONE FOOT IN LENGTH OF WIRE, OF THICKNESSES OR DIAMETERS GIVEN BY THE DECIMAL GAUGE; ENGLISH UNITS.

No. of Gauge.	Thickness or Diameter.	One square foot of sheet metal.				One foot in length of wire.			
		Iron, pounds.	Steel, pounds.	Copper, pounds.	Brass, pounds.	Iron, pounds.	Steel, pounds.	Copper, pounds.	Brass, pounds.
—3	0·5401	21·8277	22·0460	24 4650	23·1148	0·76359	0·77926	0·88290	0·85052
—2	0·4861	19·6449	19·8413	22·0185	20·8033	0·61851	0·63120	0·71515	0·68892
—1	0·4375	17·6804	17·8572	19·8167	18·7230	0·50099	0·51127	0·57927	0·55803
0	0·3937	15·9124	16·0715	17·8350	16·8507	0·40580	0·41413	0·46921	0·44300
1	0·3543	14·3211	14·4643	16·0515	15·1656	0·32870	0·33545	0·38006	0·35883
2	0·3189	12·8890	13·0178	14·4463	13·6490	0·26624	0·27171	0·30785	0·29066
3	0·2870	11·6001	11·7161	13·0017	12·2841	0·21566	0·22009	0·24936	0·23543
4	0 2583	10·4401	10·5445	11·7015	11·0557	0·17468	0·17827	0·20198	0·19070
5	0·2324	9·3961	9·4901	10·5313	9·9501	0·14150	0·14440	0·16360	0·15446
6	0·2092	8·4565	8·5411	9·4782	8·9551	0·11461	0·11696	0·13252	0·12512
7	0·1883	7·6108	7·6869	8·5304	8·0596	0·09283	0·09474	0·10734	0·10134
8	0·1695	6·8498	6·9182	7·6774	7·2536	0·07520	0·07674	0·08695	0·08209
9	0·1525	6·1648	6·2264	6·9096	6 5283	0·06091	0·06216	0·07043	0·06649
10	0·1373	5·5483	5·6037	6·2187	5·8755	0·04934	0·05035	0·05705	0·05386
11	0·1236	4·9935	5·0434	5·5967	5·2879	0·03996	0·04078	0·04621	0·04363
12	0·1112	4·4941	4·5400	5·0371	4·7591	0·03237	0·03303	0·03743	0·03534
13	0·10008	4·0447	4·0851	4·5334	4·2832	0·02622	0·02676	0·03032	0·02862
14	0·09007	3·6402	3·6760	4·0801	3·8549	0·02124	0·02167	0·02456	0·02318
15	0·08106	3·2762	3·3090	3·6721	3·4694	0·01720	0·01756	0·01989	0·01878
16	0·07296	2·9486	2·9781	3·3048	3·1225	0·01393	0·01422	0·01611	0·01521
17	0·06566	2·6537	2·6822	2·9744	2·8102	0·01129	0·01152	0·01305	0·01232
18	0·05909	2·3884	2·4123	2·6769	2·5292	0·009142	0·009330	0·01057	0·009980
19	0·05318	2·1495	2·1710	2·4092	2·2763	0·007405	0·007557	0·008562	0·008084
20	0·04787	1·9346	1·9539	2·1683	2·0487	0·005998	0·006121	0·006935	0·006548
21	0·04307	1·7411	1·7585	1·9515	1·8438	0·004858	0·004958	0·005618	0·005304
22	0·03877	1·5670	1·5827	1·7563	1·6594	0 003935	0·004016	0·004550	0·004296
23	0·03489	1·4103	1·4244	1·5807	1·4935	0·003188	0·003253	0·003686	0 003480
24	0·03140	1·2693	1·2820	1·4226	1·3441	0·002582	0·002635	0·002985	0·002819
25	0·02864	1·1423	1·1537	1·2804	1·2097	0·002091	0·002134	0·002418	0·002283
26	0·02544	1·0281	1·0384	1·1523	1·0887	0·001694	0·001729	0·001959	0·001849
27	0·02289	0·9253	0·9346	1·0371	0·9799	0·001372	0·001400	0·001587	0·001498
28	0·02060	0·8328	0·8411	0·9334	0·8819	0·001111	0·001134	0·001285	0·001213
29	0·01854	0·7495	0·7570	0·8401	0 7937	0·0009003	0·0009188	0·001041	0·0009828
30	0·01669	0·6745	0·6812	0·7560	0·7143	0·0007292	0·0007442	0·0008432	0·0007961
31	0·01502	0·6071	0·6132	0 6804	0·6429	0·0005907	0·0006028	0·0006830	0·0006448
32	0·01351	0·5464	0 5519	0·6124	0·5786	0·0004785	0·0004883	0·0005532	0·0005223
33	0·01217	0·4917	0·4966	0·5512	0·5207	0·0003876	0·0003955	0·0004481	0·0004231
34	0·01095	0·4426	0·4470	0·4960	0·4687	0·0003139	0·0003204	0·0003630	0·0003427
35	0·009856	0·3983	0·4023	0 4464	0·4218	0·0002543	0·0002595	0·0002940	0·0002776
36	0·008870	0·3585	0·3621	0·4018	0·3796	0·0002060	0·0002102	0·0002381	0·0002248
37	0·007983	0·3226	0·3258	0·3616	0 3417	0·0001668	0·0001702	0·0001929	0·0001821
38	0·007185	0.2904	0·2933	0·3255	0·3075	0·0001351	0·0001379	0·0001562	0·0001475
39	0·006466	0·2613	0·2639	0·2929	0·2767	0·0001095	0·0001117	0·0001266	0·0001195
40	0·005819	0·2352	0·2376	0·2636	0·2491	0·00008866	0·00009048	0·0001025	0·00009678
Specific Gravity.		7·769	7·847	8·708	8·228	7·6893	7·847	8·891	8·394
Weight per cu. ft.[1]		485	489·85	543·6	513·6	480	489·85	555	524
Weight per cu. in.		0·28067	0·28348	0·3146	0·2972	0·2807	0·2836	0·3212	0·3033
Weight 1 ft. long, 1 in. round.		2·6453	2·6717	2·95 .	2·8012	2·6180	2·6717	3·0283	2·8580

[1] These figures for weight per cubic foot were adopted from Trautwine.

TABLE III.

WEIGHT OF ONE SQUARE METRE OF SHEET METAL, OR ONE METRE IN LENGTH OF WIRE, OF THICKNESSES OR DIAMETERS GIVEN BY THE DECIMAL GAUGE; METRIC UNITS.

No. of Gauge.	Thickness or Diameter. Centimetres.	One square metre of sheet metal.				One metre in length of round wire.			
		Iron, kilos.	Steel, kilos.	Copper, kilos.	Brass, kilos.	Iron, kilos.	Steel, kilos.	Copper, kilos.	Brass, kilos.
—3	1·3717	106·576	107·613	119·453	112·860	1·13637	1·04373	1·31391	1·24054
—2	1·2346	95·9185	96·8777	107·508	101·574	0·92046	0·93935	1 06427	1·00484
—1	1·1111	86·3267	87·1900	96·7568	91·4170	0·74557	0 76088	0·86206	0·81392
0	1·	77·6940	78·4707	87·0811	82·2753	0·60391	0·61631	0·69827	0·65928
1	0·9	69·9246	70·6238	78·3730	74·0478	0·48917	0·49921	0·56560	0·53401
2	0·81	62·9321	63·5614	70·5357	66·6430	0·39623	0·40436	0·45813	0·43255
3	0·729	56·6389	57·2053	63·4821	59·9787	0·32094	0·32753	0·37109	0·35037
4	0·6561	50·9750	51·4847	57·1339	53·9808	0·25997	0·26530	0·30058	0 28380
5	0·5905	45·8775	46·3463	51·4205	48·5827	0·21057	0·21489	0·24347	0·22988
6	0·5314	41·2898	41·7027	46·2784	43·7244	0·17056	0·17406	0 19721	0·18620
7	0·4883	37·1618	37·5334	41·6506	39 3520	0·13816	0·14099	0·15974	0·15082
8	0 4305	33·4447	34·7891	37·4855	35·4168	0·11191	0·11420	0·12939	0·12216
9	0·3874	30·1002	30·4012	33·7370	31·8751	0·090644	0·092504	0·10481	0·098953
10	0·3487	27·0901	27·3610	30·3633	28·6876	0·073422	0·074929	0·084894	0·080152
11	0·3138	24·3810	24·6248	27·3270	25 8188	0·059472	0·060692	0·068764	0·064923
12	0·2824	21·9429	22·1623	24·5945	23·2369	0·048172	0·049161	0·055699	0·052588
13	0·2542	19·7486	19·9461	22·1349	20·9132	0·039019	0·039820	0 045116	0·042596
14	0·2288	17·7737	17·9514	19·9214	18·8219	0·031606	0·032254	0·036544	0·034503
15	0·2059	15·9963	16·1563	17·9293	16·9397	0·025601	0·026126	0·029601	0·027947
16	0·1853	14·3967	14·5407	16·1364	15·2457	0·020736	0·021162	0·023977	0·022637
17	0·1668	12·9570	13·0866	14·5228	13·7211	0·016797	0·017141	0·019421	0·018336
18	0.1560	11·6613	11·1779	13·0705	12·3490	0·013605	0·013885	0·015731	0·014852
19	0·1351	10·4952	10·6002	11·7634	11·1141	0·011020	0·011246	0 012742	0·012031
20	0·1216	9·4457	9·5402	10·5871	10·0026	0·008926	0·009110	0·010321	0·009745
21	0·1094	8·5011	8·5861	9·5284	9·0022	0·007230	0·007374	0·008360	0·007893
22	0·09848	7·6510	7·7277	8·5756	8·1020	0·005857	0·005977	0·006772	0·006393
23	0·08863	6·8859	6·7548	7·7180	7·2918	0·004744	0·005379	0·005485	0·005179
24	0·07977	6·1973	6·2593	6·9462	6·5626	0·003843	0·004841	0·004443	0·004195
25	0·07179	5·5776	5·6336	6·2516	5·9064	0·003112	0·003176	0·003599	0·003398
26	0·06461	5·0199	5·0760	5·6264	5·3157	0·002521	0·002573	0·002915	0·002752
27	0·05815	4·5179	4·5631	5·0638	4·7842	0·002042	0·002084	0·002361	0 002229
28	0·05233	4·0661	4·1068	4·5574	4·3058	0·001654	0·001688	0·001912	0·001806
29	0·04710	3·6595	3·6961	4·1017	3·8752	0 001340	0·001367	0·001549	0·001463
30	0·04239	3·2936	3·3265	3·6915	3·4877	0·001085	0·0011075	0·001255	0·001185
31	0·03815	2·9642	2·9938	3·3223	3·1389	0·0008790	0·0008971	0·0010164	0·0009596
32	0·03434	2·6678	2·6945	2·9901	2·8251	0 0007120	0·0007266	0·0008233	0·0007773
33	0·03090	2·4010	2·4250	2·6911	2·5425	0·0005767	0·0005886	0 0006669	0·0006296
34	0·02781	2·1609	2·1825	2·4220	2·2883	0·0004204	0·0004767	0·0005402	0·0005100
35	0·02503	1·9448	1·9642	2·1798	2·0595	0·0003784	0 0003862	0·0004375	0·0004131
36	0·02253	1·7504	1·7679	1·9618	1·8535	0·0003065	0·0003128	0·0003544	0·0003346
37	0·02028	1·5753	1·5911	1·7656	1·6682	0 0002483	0·0002534	0·0002871	0·0002710
38	0·01825	1·4178	1·4320	1 5891	1·5013	0 0002011	0·0002052	0·0002325	0·0002195
39	0·01642	1·2760	1·2888	1·4302	1·3512	0·0001629	0·0001662	0·0001883	0·0001778
40	0·01478	1·1484	1·1599	1·2871	1·2161	0·0001319	0·0001346	0·0001526	0·0001440
Specific Gravity.		7·769	7·847	8·708	8·228[1]	7·6893	7·847	8·891	8·394[1]

[1] Value of specific gravity of brass sheets or wire dependent on the composition of brass.

*Stubs' Birmingham Wire Gauge expressed Metrically and in Decimal and Vulgar Inch Fractions.**

Gauge.	Inches.	Inches.	Millimetres.	Gauge.	Inches.	Inches.	Millimetres.
1	..	.3	7.62	14	....	.083	2.1082
2	..	.284	7.2136	15	....	.072	1.8288
3	..	.259	6.5786	16	....	.065	1.7510
4	$\frac{1}{4}$ —	.238	6.0452	17	....	.058	1.4732
5	$\frac{7}{32}$	.22	5.588	18	....	.049	1.2446
6	$\frac{3}{16}$ +	.203	5.1562	19	....	.042	1.0668
7	$\frac{3}{16}$ —	.18	4.572	20	....	.035	.8890
8	$\frac{5}{32}$	.165	4.291	21	....	.032	.8128
9	$\frac{9}{32}$ —	.148	3.7592	22	....	.028	.7012
10	$\frac{1}{8}$ +	.134	3.3036	23	....	.025	.6350
11	$\frac{1}{8}$ —	.12	3.048	24	....	.022	.5588
12	$\frac{1}{8}$ —	.109	2.7686	25	....	.02	.5080
13	$\frac{3}{32}$	.095	2.4130	26	....	.018	.4572

Table of Revolutions per Minute for Various Rim Speeds.

Diameter Inches	Rim Speed, Feet per minute.				
	9,000	10,000	11,000	12,000	13,000
8	4297.12	4774 62	5252.	5732.50	6207.
10	3437.70	3819.70	4201.60	4586.	4965.60
12	2864.75	3183.08	3501.33	3821.66	4138.
14	2455.50	2728.35	3001.14	3275.71	3546.85
16	2148.56	2387.31	2626.	2866.25	3103.50
18	1905.94	2122.05	2334.22	2547.77	2578.66
20	1718.85	1909.85	2100.80	2293.	2482 80
22	1562.59	1736.22	1909.81	2084.54	2257.09
24	1432.37	1591.54	1750.66	1910.08	2069.
26	1322.19	1469.11	1616.	1763.84	1909.84
28	1227.75	1364.17	1500.57	1637.85	1773.09
30	1145.90	1273.23	1400.53	1528.66	1655.20
32	1074.28	1193.65	1313.	1433.12	1551.75
34	1011.08	1123.44	1235.76	1348.82	1460.47
36	954.91	1061.92	1167.11	1273.88	1379.33
38	904.65	1005.18	1105.68	1206.84	1306.73
40	859.42	954.92	1050.40	1146.50	1241.40
42	818.5	909.45	1000.38	1091 90	1182.28
44	781.29	868.11	954.90	1042.27	1128.54
46	747.32	830.36	913.39	996.95	1079.47
48	716.19	795.77	875.33	955.41	1034.50
50	697.54	763.94	840.32	917.20	993.12
52	661.09	734.55	808.00	881.92	954.92
54	636.61	707.35	778.07	849.25	919.55
56	613.87	682.68	750 28	818.92	886.71
58	592.70	658.56	724.41	790.68	856.13
60	572.86	636.61	700.26	764.43	827.60
62	554.46	616.08	677.67	739.67	800.90
64	537.14	596.51	656.50	716.56	775.87
66	520.86	578.74	636.60	694.84	752.36
68	505.54	561.72	617.88	674.41	730.23
70	491.10	545.67	600.22	655.14	709.37
72	477.45	530.51	583.55	636.94	689.66
74	464.55	516.17	567.78	619 72	671.02

* See p. 144.

Table of Lineal Velocity of Belts or of Band Saws (given in feet per minute), on Pulleys of given Diameters, at Various Speeds.

Diam. Pulley.	Revolutions per Minute.					
	300	350	400	450	500	600
30 in.	2356	2749	3142	3534	3927	4712
32 "	2513	2932	3351	3770	4189	5026
34 "	2670	3115	3560	4005	4451	5341
36 "	2827	3298	3770	4241	4712	5654
38 "	2984	3482	3979	4477	4974	5969
40 "	3141	3665	4189	4712	5236	6283
42 "	3298	3848	4398	4948	5498	6597
44 "	3455	4031	4607	5184	5760	6911
46 "	3612	4215	4817	5419	6021	7226
48 "	3770	4398	5027	5655	6283	..
50 "	3927	4581	5236	5890	6545	..
52 "	4084	4765	5445	6126	6807	..
54 "	4241	4948	5655	6362	7069	..
56 "	4398	5131	5864	6591	7330	..
58 "	4555	5314	6074	6833	7692	..
60 "	4712	5497	6283	7069	7854	..

Rule.—To find lineal velocity of a band saw or a belt in feet per minute—multiply diameter in inches by $\frac{3.1416}{12} = .2618$ and by the number of revolutions per minute.

Rule.—To find the number of revolutions per minute of circular saws, pulleys, or wheels of various diameters corresponding to a given rim speed. Multiply the diameter in inches by 3.1416 and divide the product into twelve times the rim speed in feet, or divide the diameter in inches into 3.82 times the rim speed.

Less accurately; divide 11 times the diameter in inches into 42 times the rim speed in feet.

Diameter and Thickness of American Concave Saws, expressed Metrically (corresponding to Table on page 67).

Diameter, mm.	Thickness, mm.
152.39	1.2446
177.19	1.2446
208.19	.....
253.99	1.7510
304.79	1.8288
355.59	.....
406.39	2.1082
457.19	2.4130
507.99	.....

Diameters and Thickness of American Circular Saws, with Size of Mandrel Holes, expressed Metrically (corresponding with Table on page 56).

Diameters, cm.	Gauge.	Mandrel Hole, mm.
10.16	19	19.04972
12.70	19	"
15.40	18	"
17.78	18	"
20.32	18	22.22479
22.86	17	"
25.40	16	25.39977
30.48	15	"
35.56	14	47.6045
40.64	14	"
45.72	13	31.74971
50.80	13	33.32
55.88	12	"
60.96	11	24.91
66.04	11	"
71.12	10	38.08
76.20	10	"
81.28	10	41.26
86.36	9	"
91.44	9	"
96.52	8	"
101.60	8	50.79
106.68	8	"
111.76	7	"
116.84	6	"
121.92	6	"
127.	6	"
132.08	5	"
137.16	5	"
142.24	5	"
147.31	5	"
152.39	5	"
158.48	4	"
162 55	4	"
168.67	4	"
173.72	4	"
178.79	3	"
183.57	3	"

Richards' Speed Table for Circular Saws. (Expressed Metrically by R. G.)

Diameter.		Revolutions per Minute.	Peripheral Velocity.	
Inches.	Centimetres.		Metres per minute.	Feet per minute.
36	91.44	1500	4300	14100
30	76.20	1800	4300	14100
25	63.50	2100	4150	13700
20	50.80	2400	3800	12500
15	38.10	2700	3225	10600
10	25.40	3000	2125	7000

Circumference of Wheels, Pulleys, or Circular Saws. (*Original.*) *Diameters being given in Inches and Centimetres, and Circumferences being given in Feet and Metres.*

Diameter, inches.	Circumference in feet.	Circum. in metres.	Diam. centimetres.
8	1.9344	.6848	20.32
10	2.6181	.7975	25.40
12	3.1416	.9570	30.48
14	3.6652	1.1178	35.60
16	4.1888	1.2760	40.64
18	4.6124	1.4356	45.72
20	5.2360	1.5951	50.80
22	5.7596	1.7546	55.88
24	6.2832	1.9141	60.96
26	6.8068	2.0736	66.04
28	7.3304	2.2331	71.12
30	7.8540	2.3926	76.20
32	8.3776	2.5521	81.28
34	8.9012	2.7117	86.36
36	9.4248	2.8712	91.44
38	9.484	3.0304	96.51
40	10.472	3.1899	101.59
42	10.9956	3.3497	106.68
44	11.5192	3.5092	111.76
46	12.0428	3.6687	116.84
48	12.5664	3.8282	121.92
50	13.09	3.9878	127.00
52	13.6136	4.1473	132.08
54	14.1372	4.3068	137.16
56	14.6608	4.4663	142.24
58	15.1844	4.6258	147.32
60	15.708	4.7853	152.40
62	16.2316	4.9448	157.48
64	16.7552	5.1043	162.56
66	17.2788	5.2638	167.64
68	17.8024	5.4234	172.72
70	18.3260	5.5829	177.80
72	18.8496	5.7424	182.88
74	19.3742	5.9019	187.96

The Circumference or Periphery of a Saw.—Multiply its diameter by 3.1416, or more roughly by 3¼ (that is, multiply by 22 and divide by 7).

Circumference in Feet.—Multiply the diameter in inches by .2618; or multiply the diameter in inches by 11 and divide by 42.

Rim Speed in miles per minute is found by multiplying the diameter in inches by the number of revolutions per minute and dividing by 20168.

Table of Rotation Speed for Circular Saws to give a rim speed of 9420 *feet*= 2871 *metres per minute. Diameters expressed Metrically and in Inches.*

Diameter, Inches.	Diameter, cm.	Revolutions per minute.	Diameter, Inches.	Diameter, cm.	Revolutions per minute.
8	20.32	4500	42	106.68	870
10	25.40	3600	44	111.76	840
12	30.48	3000	46	116.84	800
14	35.60	2585	48	121.92	750
16	40.64	2222	50	127.00	725
18	45.72	2000	52	132.08	700
20	50.80	1800	54	137.16	675
22	55.88	1636	56	142.24	650
24	60.96	1500	58	147.32	625
26	66.04	1384	60	152.40	600
28	71.12	1285	62	157.48	575
30	76.20	1200	64	162.56	550
32	81.28	1125	66	167.64	545
34	86.36	1058	68	172.72	529
36	91.44	1000	70	177.80	514
38	96.51	950	72	182.88	500
40	101.59	900			

One metre equals 39.37043 inches, 3.28087 feet, 1.09362 yards.
One inch equals 2.53995 centimetres.
One foot equals 0.3048 metre.
One square inch equals 6.45148 square centimetres.
One square foot equals .0092901 square metre.
One square yard equals 0.836112 square metre.

Dark-red color indicates about 700° Cent., equals 1292° Fahr.; cherry red, 1652° Fahr.; white heat, 2372° Fahr.

List of Saw Patents up to April, 1882.

Drag Saw,	M. P. Hall,	Jan. 13, 1880, 223,504
Saw,	A. A. Burr,	Mar. 23, 1880, 225,795
Scroll Saw,	D. F. Sutton,	Mar. 30, 1880, 226,130
Drag Saw,	J. Angspurger,	Apr. 20, 1880, 226,390
	J. A. Cluxton,	Apr. 20, 1880, 226,718
Endless Chain Saw,	E. Nunan,	Apr. 20, 1880, 226,774
Drag Saw,	J. K. Hutchins,	May 4, 1880, 227,110
Circular Saw,	J. K. Lockwood,	May 11, 1880, reissue 9197
Saw,	E. Morris,	May 18, 1880, 227,815
	C. Suisse,	July 6, 1880, 229,772
Drag,	J. Carothers,	June 22, 1880, 229,091
	M. B. Swindell,	June 29, 1880, 229,488
	C. S. Dean,	July 13, 1880, 229,975
	N. L. Brown,	Aug. 24, 1880, 231,474
	J. Oldham,	Oct. 5, 1880, 233,008
Drag Mach.	J. J. Thomas & N. F. Mills,	Oct. 12, 1880, 233,126
Drag,	J. M. Da Costa,	Oct. 19, 1880, 233,403
Saw Teeth,	G. F. Woolston,	Mar. 11, 1851, 7,979
	N. Barlow,	Apr. 10, 1855, 12,664
	I Mason,	Sept. 11, 1860, 29,982
	I. S. Brown,	Jan. 8, 1861, 31,073
	L. B. Southwark	July 9, 1861, 32,796
	J. E. Emerson,	Sept. 12, 1865, 49,868
	E. Colson,	May 4, 1869, 89,559
	"	Nov. 9, 1869, 96,674
	P. Cook,	Feb. 23, 1869, 87,092
	J. Newton,	Aug. 24, 1869, 94,022
	U. B. Noyes,	Oct. 5, 1869, 95,602
	I. & T. Bird, Jr.,	Dec. 27, 1870, 110,430
	G. H. Hiles,	May 17, 1870, 103,045
	C. V. Littlepage,	July 12, 1870, 105,345
	J. E. Emerson,	Apr. 29, 1873, 138,236
	" "	Sept. 16, 1873, 142,781
	U. P. Miller,	Aug. 26, 1873, 142,258
Saw Teeth Bl'k,	J. E. Emerson,	Sept. 16, 1873, 142,780
	" "	Nov. 8, 1870, 108,990
Circular,	N. Johnson,	May 21, 1872, 127,061
Construction of	W. A. Wilson,	Mar. 22, 1859, 23,339
Detachable,	G. J. Hogan,	Apr. 26, 1870, 102,400
Insertable,	W. H. Ivens,	May 9, 1871, 114,683
	N. Johnson,	Dec. 24, 1872, 134,290
	H. G. Powell,	Aug. 20, 1872, 130,659
	J. W. Strange,	Aug. 13, 1867, 67 682
Removable,	J. Crookes,	Aug. 5, 1873, 141,427
Saw Tooth,	J. E. Emerson,	May 26, 1874, 151,321
	J. R. Luce,	May 26, 1874, 151,407
	M J. Rahilly,	Jan. 20, 1874, 146,708
B'd Saw Teeth,	A. Hatch,	Mar. 31, 1874, 149,120
Saw Teeth,	W. P Hale,	Apr. 13, 1875, 162,061
Saw Teeth Circ.	A. F. Dimond,	Dec. 28, 1875, 171,604
Insertable,	E. Smith,	Apr. 28, 1875, 162,319
Saw Teeth,	A. Boynton,	Aug. 15, 1876, 180,986
Insertable,	C. Adams,	May 16, 1876, 157,446
	H. Disston,	May 16, 1876, 177,481
	T. S. Disston,	May 30, 1876, 178 123
	E. C. Keys,	Aug. 1, 1876. 180,429
	E. T. Leppert,	June 6, 1876, 178,450
	T. S. Disston,	Apr. 3, 1877, 189,199
Saw Tooth,	N. W. Spaulding	June 19, 1877, 192,099
	" "	June 19, 1777, 192,090
	C. Adams,	June 11, 1878, 204,697
	W. E. Brooks,	June 18, 1878, 205,042
	J. R. Luce,	Dec. 17, 1878, 211,029
	W. P. Miller,	Dec. 17, 1878, 211,035
Saw Tooth, Insertable,	J. R. Berry,	Aug. 13, 1878, 207,003
	S. J. Randall & J. O'Brien,	Feb. 12, 1878, 200,219
	F. Schley,	Nov. 5, 1878, 209,627
	J. Ohlen,	Nov. 11, 1879, 221,602
	N. Johnson,	Jan. 7, 1879, 211.097
Inserted,	R. H. Osgood,	Dec. 2, 1879, 222,304
Saw,	C. H. Douglas,	Jan. 25, 1881, 236,876
	C. N. Hubbard,	Apr. 12, 1881, reissue, 9,617
	C. R. Marvin,	June 14, 1881, 242,951
	E. Osgood,	Mar. 8, 1881, 238,521
	J. Ashenfelter,	Aug. 2, 1881, 245,114
	G. H. Northway,	Aug. 2, 1881, 245,090
	H. Van Bibber,	Aug. 9, 1881, 245,588
	S. Toles,	Nov. 1, 1881, 249,119
	H. Westphal,	Dec 20, 1881, 251,149
Saw Tooth,	E. J. Hill,	Mar. 22, 1881, 239,098
	E. C. Mulford,	Jan. 18, 1881, 236,690
	E. S. Snyder,	May 3, 1881, 241,082
	C. N. Hubbard,	Aug. 16, 1881, 245,831
Detach.	E. C. Atkins,	Sept. 6, 1881, 246,703
Insert.	A. Krieger,	Oct. 25, 1881, 248,761
Back,	J. R. Woodrough	Jan. 17, 1882, 252,571
Circular,	G. F. & D. Simonds & A. A. Marshall	Feb. 8, 1881, 237,617
Compress,	C. Bush,	Jan. 10, 1882, 252,179
Crosscut,	E. M. Boynton,	Feb. 14, 1882, 253,671
	" "	Apr. 5, 1881, 239,710
	J. E. Emerson,	Mar. 22, 1881, 239,156
Drag,	J. M. De Coster,	Oct. 19, 1880, 233,403
	J. P. Fosdyck,	Oct. 26, 1880, 236,610
	J. Angspurger,	Nov. 2, 1880, 233,907
	S. Clemens,	June 14, 1881, 242,883
	E. Strobl,	June 14, 1881, 243,004
	M. L. Nichols,	Oct. 11, 1881, 248,200
	S. Males,	Dec. 6, 1881, 250,557
Drag for Cutting Snags,	J. W. Swales,	May 17, 1881, 241,749
Fire w'd Drag,	W. Warmoth,	Aug. 23, 1881, 246,253
Hand,	J. R. Woodrough	Jan. 17, 1882, 252,570
Saw, Hand,	L. Lawson,	Oct. 11, 1881, 248,045
Circular,	A. A. Bennett,	Apr. 5, 1881, 239,703
Jig,	C. P. Warwick,	June 21, 1881, 243,092
Reaming,	L. Barthelmes,	Apr. 5, 1881, 239,698
Scroll,	W. Jones,	Jan. 4, 1881, 236,163
	F. Schaefle,	Feb. 15, 1881, 237,912
Swing,	J. Connell & V. Dengler,	Feb. 14, 1882, 253,513
Swinging,	W. F. Rothenberg,	Apr. 19, 1881, 240,339
Sawing Mach.	S. W. Brown,	Oct. 26, 1880, 233,597
	A. F. Morris,	Nov. 30, 1880, 234,886
	F. J. Crump,	Apr. 26, 1881, 240,667
	L. S. Edleblute,	June 21, 1881, 243,114
	E. R. Hill,	July 5, 1881, 243,896
	J. Angspurger,	Aug. 30, 1881, 246,448
	L. D. Noblett,	Aug. 30, 1881, 246,540
	D. Berry,	Nov. 29, 1881, 250,191
	C. W. Trautman	May 10, 1881, 241,449
	A. Euston,	Feb. 28, 1882, 254,202
Sawing Mach. Band,	L. F. Ketler,	Jan. 10, 1882, 250,043
Circular,	H. J. Colburn,	Dec. 6, 1881, 250,425
	" "	Dec. 13, 1881, 250,712

Sawing Circ.	C. S. Beath,	July 5, 1881, 243,835
	D. O. Strifler,	July 12, 1881, 244,335
Crosscut,	W. H. Smith,	Jan. 17, 1882, 250,043
	J. M. Turner,	Feb. 15, 1881, 237,930
Cut. down stand. timb'r,	J. Angspurger,	Aug. 30, 1881, 246,447
Drag,	L. M. Comstock,	Oct. 26, 1880, 233,731
	L. H. & J. E. Gibbs	May 24, 1881, 241,960
	T. J. Hennberg,	Apr. 26, 1881, 240,515
	J. W. McKee,	Jan. 4, 1881, 236,236
Sawing Mach. Drag,	N. McAdams, Jr.	July 12, 1881, 244,278
	S. B. & E. Allen,	Aug. 16, 1881, 245,693
	E. L. & J. A. Dunham,	Aug. 16, 1881, 245,800
	G. B. Durkee,	Nov. 29, 1881, 250,136
	D. H. Ball,	Dec. 27, 1881, 251,504
Saw'g Groov. & Plan'g Mach.	G. M. & N. Fay,	Mar. 15, 1881, 238,875
Sawing Mach. Hand,	N. W. Giles,	Apr. 19, 1881, 240,316
	N. M. Lawrence,	May 3, 1881, 241,031
	M. Kurtzeman,	Sept. 13, 1881, 247,069
Heading Stave Spoke,	G. W. Wilson,	July 5, 1881, 243,745
Sawing kindl'g w'd, Mach. for,	J. H. Brown,	Feb. 1, 1881, 237,161
Sawing kindl'g w'd, Mach. for,	N. A. Allen,	Oct. 25, 1881, 248,686
Saw'g Mach. log	C. B. Halstead & J. A. Carpenter,	Jan. 3, 1882, 251,872
Sawing Mach., Port. Rail.	J. McKinney,	Jan. 28, 1882, 243,595
Rim,	O. F. Sillcot,	Jan. 10, 1882, 252,268
Saw'g & Rout'g Mach.	S. M. Bragg,	Feb. 8, 1881, 237,475
Sawing Mach.	N. D. Herschell,	Oct. 26, 1880, 233,752
Scroll & Circ.	A. Showalter,	Feb. 14, 1882, 253,777
Sawing Mach. Shingle,	O. C. Hanson,	Dec. 7, 1880, 235,233
	D. Lane,	Feb. 1, 1881, 237,294
	N. H. Perkins,	Jan. 11, 1881, 235,620
	H. F. Snyder,	Apr. 12, 1881, 240,048
Tenon,	N. H. Clayton,	Nov. 2, 1880, 233,981
Wood,	N. H. Mellott,	May 24, 1881, 242,016
	C. F. Needham,	Apr. 19, 1881, 240,050
Saw Mill,	C. A. Hege,	June 28, 1881, 243,536
Band,	C. Meiners,	Aug. 30, 1881, 246,330
Saw Mill Circ.	C. J. L. Meyer,	Jan. 24, 1882, 252,689
Saw Mill Circ.	J. Campbell,	Feb. 28, 1882, 254,110
Gang,	J. M. Story,	Dec. 21, 1880, 235,824
	G. W. Nichols,	May 17, 1881, 241,699
Portable,	W. N. Whipple,	Sept. 27, 1881, 247,726
Reciprocating,	G. Gowen & A. Williams,	May 24, 1881, 241,857
	T. S. Wilkin,	Jan. 25, 1881, 236,968
Steam,	A. J. Emlaw,	Aug. 30, 1881, 246,380

The above comprises all United States Patents in the class of Saws from October 19th, 1880, to March 7th, 1882, inclusive.

Compiled by

JOHN A. WIEDERSHEIM,

Solicitor of Patents,

No. 110 S. Fourth St., Philadelphia, Pa.

Through whom copies of specifications, drawings, and claims may be ordered and obtained.

ALPHABETICAL SUBJECT INDEX

TO

SUPPLEMENT TO GRIMSHAW ON SAWS.

Adjustable dished circulars, 236
  veneer saws, 236
Adjusting tension of circulars, 263
American circular saws, diameters expressed metrically, 272
  thickness of, expressed metrically, 272
  decimal, and Birmingham gauges compared, 265
  gauge, 265
Andrews, E., old saw anvil, 264
Anvil, old saw, 264
Arbey, packing, 241
Arbor, McDonald, hollow, 241
  mending broken, by C. G. Osgood, 263
Atkins inserted tooth, 238
Atlantic works, filing frame, 258
  band saw setting machine and filing frame, 258

Band saw filing machine, Howe's, 260
  setting machine and filing frame, 258
  Fay & Co., 261
  Howe's, 260
  of Atlantic works, 258
  teeth, 258
Barrel heads, 235
  and shingle work, speed of circular saw for, 234
Bennet's hand circular, 240
Bevelled edge heads, 235
Bidwell, W. H., 234
Birmingham gauge, 265
  decimal and American gauges compared, 265
  gauge expressed decimally and in vulgar fractions, 270
Briggs, Robert, decimal gauge, 265
Broken teeth, 248
Brown & Sharpe's gauge, 265

Cheese-box heads, 235
Circle, pitch, 232
Circular saw, Osgood's side cutting, 239
  Simonds' loose, 238
  smallest, 233
  saws, circumference of, 273
  direct driven, 246
  double, 246
  friction of, 240
  packing, 241
  rim speed of, 273
  speed of, 235
  table of rotation speed, 273
  three high, 246
  saw teeth, pitch of, 248
Circumference of wheels, pulleys, or circular saws, 273
Collars, facing, 240
  fast, 240
Comparison of decimal, American, and Birmingham gauges, 265
Concave saws, diameter and thickness expressed metrically, 271
  filing, 235
  speed of, 235

Decimal gauge for sheet metal and wire, 265
  American, and Birmingham gauges compared, 265
Diameter and thickness of concave saws expressed metrically, 271
Diameters expressed metrically and in inches, 274
  of American circulars expressed metrically, 272
Direct driven circulars, 246
Dished circulars, adjustable, 236
Double circulars, 246
Douglas' insertable tooth, 237

Emerson, J. E., 241
Ford & Co., quick saw making, 263
End play, 244

Facing collars, 240
Fast collars, 240
Fay & Co., band saw setting machine, 261
Fibrous materials, 264
Filing concave saws, 235
frame of Atlantic works, 258
First saw-mills in England, 262
Floors, Scandinavian, 262
Frey, Scheckler & Hoover, 246
Friction circular, 240
Frozen timber, 248

Gauge, American, 265
Brown & Sharp's, 265
Birmingham, 265
of shingle saws, 264
Stubbs, 265
Goodell & Waters, 236
Grandy, C. E., on bull's eye, 226
cam power sets, 180, 181
cleaner teeth, 176
inserted teeth, 232
non-hammered saws, 228
perforated crosscut, 203
rim tapering, 222
round gullets, 176
sheared teeth, 177
Granular materials, 264
Greenwood & Co., John, 234
Grooving saws, sectional, 235
Guide for circulars, Hinckley's, 241
Gumming saws, 233

Hand circular, Bennet's, 240
Heads, bevelled edged, 235
for barrels, 235
for cheese-boxes, 235
Hill's insertable tooth, 238
Hinckley saw guide, 241
Holland, John, 234
Hollow arbor, McDonald, 241
Howe's band saw filing machine, 260
setting machine, 260
Hubbard relayed tooth, 237

Insertable tooth, Hills', 238
Mulford's, 237
Inserted tooth, Atkins', 338
Douglas', 237
Kringer's, 236
Iron, specific gravity of, 265

Kerf, waste by, 244
Kringer's inserted tooth, 236

Lineal velocities of belts or band saws on pulleys of given diameters and various speeds, table, 271
Logs, cutting ten-foot, 246
Loose collars, 240
Lubricant, waste of, 244
water as, 241
Lug pins, 240
Lumber, power required to cut, 244

Mandrel holes, sizes of, metrically expressed, 272
Mandrels, saw, 240
Materials, fibrous, 264
granular, 264
McDonough hollow arbor, 241
saw arbor, 239
saw relief, 244
Mending broken arbor, C. G. Osgood, 263
Miles per minute, rim speed in, 273
Molesworth, G. L., 244
Mulford's insertable tooth, 237

Northway's planing saw, 239

Old saw anvil, 264
Open wheel, 244
Osgood, C. G., mending broken arbor, 263
side cutting circular, 239

Packing circulars, 241
collars with paper, 241
Arbey, 241
Worssam, 241
Paper for packing collars, 241
Perforated inserted tooth saws, 233
Pins, lug, 240
steady, 240
Pitch circle, 233
of circular saw teeth, 248
Planing saw, Northway's, 239
Play, end, 244
Power to cut lumber, 244
Pulleys, circumference of, 273

Quick saw making, 263

Range, 241
Relayed tooth, 237
Reliance Works, 241–243
Relief for circulars, McDonough's, 244
Richards' speed table for circulars, expressed metrically, 272
Rim speed of circular saws, 273
speeds, tables of, 270
speed in miles per minute, 273
Rotation speed for circulars to give rim speed of feet per minute, table of, 273
Round teeth, 248
Rules for lineal velocity of belt, band saws, &c., 271

Sawed veneers, 264
Scandinavian floors, 262
Screw nicking, small circular saw for, 234
Works, Union, 234

Sectional grooving saws, 235
Setting band saw teeth, 258, 260, 261
Sheared teeth, 248
Sheet metal and wire, weight of, 268, 269
Shingle saws, gauge of, 264
Simonds' loose circular, 238
  method of adjusting unequal tension in circulars, 263
  patent for correcting unequal tension in circulars, 262
Sizes of mandrel holes expressed metrically, 272
Smallest circular saw, 233
Small circulars for screw nicking, 234
Specific gravity of iron, 262
Speed of circular saws for barrel and shingle work, 234
Speeds of circulars, 235
  Richards' table, expressed metrically, 272
Steady pins, 240
Stone sawing, 264
Stubbs' Birmingham gauge expressed metrically and in decimal and vulgar fractions, 270
  gauge, 265

Tables, 272
Table of lineal velocity of belt or band saws on pulleys of given diameters and various speeds, 271
  of revolutions per minute for various rim speeds, 270
  of rotation speed for circulars to give rim speed of feet per minute, 273
Tatum, Bowen & Co., 246
Teeth, broken, 248
  round, 248
  sheared, 248
Temper of concave saws, 235
Ten-foot logs, cutting, 246
Tension in circulars, correcting uneven, 262
  of circulars, adjusting, 263
  Simonds' patent for correcting unequal in circulars, 262
Thickness of American circulars expressed metrically, 272
Three high circular, 246
Timber, frozen, 248

Union Screw Works, 234

Velocity of belt and band saws, rules for, 271
Veneers, sawed, 264
Veneer saws, adjustable, 236

Waste by kerf, 244
Waste of lubricant, 244
Water as lubricant, 241
Weights of sheet metal and wire, 268, 269
Wells, S. B., 236
Wheel, open, 244
Wheels, circumference of, 273
Wire, decimal gauge for sheet metal and, 265
  and sheet metal, weight of, 268, 269
Worssam's packing, 241

PATENT

Wood-Working Machinery,

FOR

Planing Mills, Sash and Door Work, Furniture, Chair, and Bracket Factories, Car Shops, and General Wood Workers, etc.,

OF THE

LATEST AND MOST-IMPROVED DESIGN.

MANUFACTURED BY

CORDESMAN, EGAN & CO.,

Nos. 234, 236, 238, 240, 242, 244, 246, 248 & 250 W. FRONT STREET,

CINCINNATI, O., U. S. A.

PERIN BAND SAW BLADES.

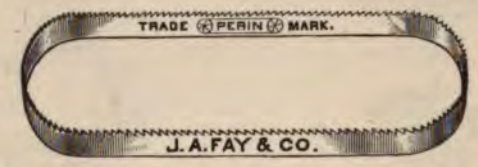
"KNOW ALL MEN BY THESE PRESENTS: *That we,* **PERIN, PANHARD & CO.,** *of* **Paris, France,** *have this day withdrawn the agency for the sale of our* **Band Saw Blades** *from Messrs. London, Orton & Berry, successors to Messrs. Richards, London & Kelley, Phila., and appoint Messrs.*

J. A. FAY & CO.,

of **Cincinnati, O., U. S. A.,** *to be our sole and exclusive agents for the entire States and territories of the United States of America, with full power to prosecute all infringements and illegal abuse of our trade mark. Made in Paris, France, Jan.* 1, 1878"

Witness,
W. TARAZIN.

PERIN, PANHARD & CO.,
Successors to Perin & Co.



As will be seen from the above announcement, we have been appointed sole and exclusive agents for the United States of the celebrated PERIN BAND SAW BLADES, and can furnish any sizes and lengths that may be required, joined, filed, and set, ready for use. Special sizes and lengths, not in stock, will be imported—requiring about thirty days from receipt of order. All blades will bear the trade mark: **Perin & Co.**, on one side, and **J. A. Fay & Co.** on the other side. *Genuine Perin Blades* can only be procured from us or our authorized agents.

J. A. FAY & CO.,

MANUFACTURERS OF

BAND SAWING MACHINERY,

VIZ.:

Band Log-Sawing Machines for Logs.
Band Re sawing Machines for Lumber.
Band Scroll-Saws for all kinds of Straight and Curve-Cutting required in Car and Railroad Shops, Carriage, Wagon, Sash and Door, Cabinet and Agricultural Implement Works, etc etc.

ILLUSTRATIONS AND PRICES SUPPLIED ON APPLICATION.

J. A. FAY & CO.,

W. H. DOANE, President.
D. L. LYON, Secretary.

Cor. John & Front Streets, CINCINNATI, O.

J. A. FAY & CO.,

CINCINNATI, OHIO, U. S. A.,

MANUFACTURERS OF

PATENT IMPROVED

WOOD-WORKING MACHINERY.

VIZ.:

PLANING, MATCHING, AND BEADING MACHINES, SURFACE PLANING MACHINES, MORTISING AND BORING, MOULDING TENONING, CARVING, PANELING, AND SHAPING MACHINES, BAND AND SCROLL SAWS, CIRCULAR, RIPPING, AND CROSS-CUTTING SAWS, BAND AND CIRCULAR RE-SAWING MACHINES, ETC. ETC.

UNIVERSAL AND VARIETY WOOD WORKERS.

DESIGNED FOR USE IN

PLANING MILLS, SASH, DOOR, AND BLIND FACTORIES,

CARRIAGE-WHEEL and SPOKE FACTORIES,

Agricultural Implement Works,

CAR, RAILROAD, AND BRIDGE SHOPS,

FURNITURE and CABINET FACTORIES, etc. etc.

Our Machines have received HIGHEST AWARDS at all the International Expositions.

GRAND GOLD MEDAL OF HONOR AT PARIS, 1878.

CIRCULARS AND QUOTATIONS FURNISHED ON APPLICATION.

J. A. FAY & CO.,

W. H. DOANE, Pres't.
D. L. LYON, Sec'y.

CINCINNATI, OHIO.

LANE & BODLEY CO.,

MANUFACTURERS OF

STATIONARY AND PORTABLE

STEAM ENGINES,

PORTABLE AND STATIONARY

Circular Saw Mills,

Gang Edgers,

Lath Machines,

BOLTING, EDGING AND CUT-OFF

SAWS,

VENEER SAWS,

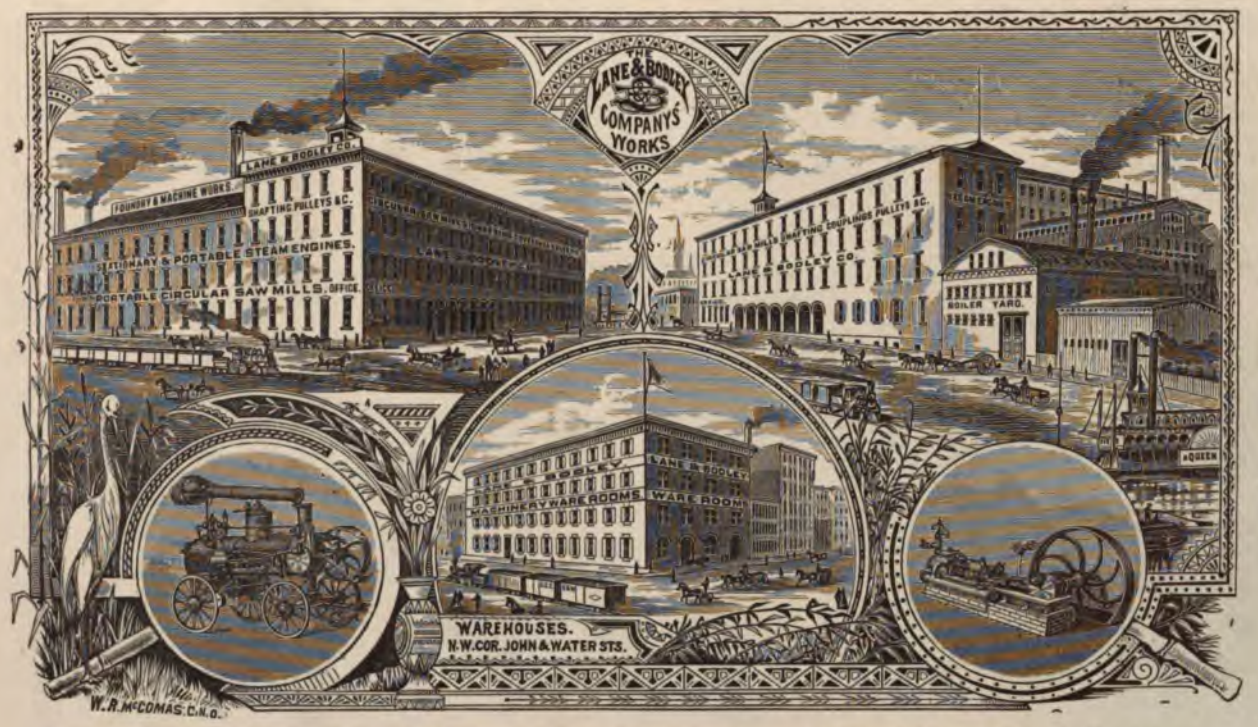
Re-sawing and Cigar-Box Machines, Shafting, Hangers, Pulleys, Couplings, Gearing, and Mill Outfits and Supplies.

CATALOGUES FREE.

LANE & BODLEY CO.,

John and Water Streets,

CINCINNATI, OHIO.



LANE & BODLEY CO., Manufacturers of Sawing Machinery,

Illustrated Catalogue and Prices furnished on application. CINCINNATI, OHIO.

LONDON, BERRY & ORTON,

ATLANTIC WORKS,

PHILADELPHIA, PA., U. S. A.,

MANUFACTURERS OF

WOOD-CUTTING MACHINERY

OF ALL DESCRIPTIONS.

SPECIALTIES:

Band Sawing Machinery,

and Band Saw Blades,

FOR SAWING

Wood, Plate,
Ivory, Cloth,
Bone, Hard Rubber,
Metal, Slate, etc.

BAND SAWING MACHINES

FOR HEAVY LOG SAWING,

Taking in Logs up to 8 feet in diameter, any length.

These machines save 23½ per cent. of lumber in kerf over circular saws.

Cable address,

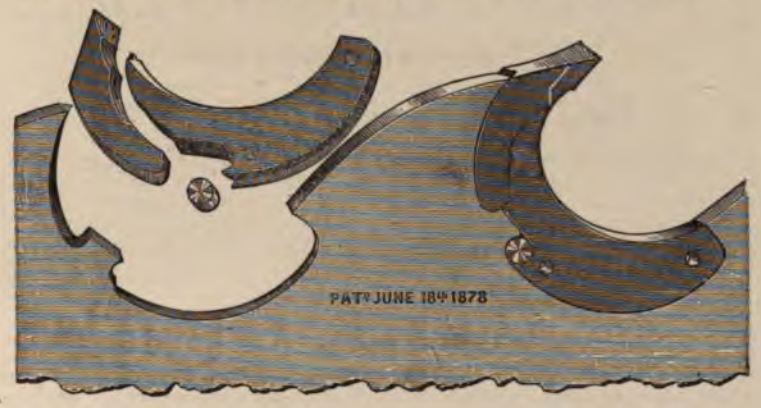
ORTON, Philadelphia.

American Saw Company,

TRENTON, N. J.,

MANUFACTURERS OF

INSERTED TOOTHED CIRCULAR SAWS.



ALSO

PERFORATED CROSS CUT SAWS,

AND

SOLID SAWS OF ALL KINDS.

SEND FOR DESCRIPTIVE PAMPHLET.

IN PREPARATION.

Grimshaw on Sawing Machinery.

HISTORY, CLASSIFICATION AND COMPARISON, CONSTRUCTION, INSTALLATION AND USE OF AMERICAN AND EUROPEAN

SAWING MACHINERY

OF ALL KINDS.

By ROBERT GRIMSHAW.

A SEQUEL TO THE AUTHOR'S WORK ON SAWS,

Being mainly drawn from the writer's long-collected personal notes, and from official data, obtained as member of the Jury of Awards on Wood Working Machinery at the Paris Exposition of 1878.

PARTIAL TABLE OF CONTENTS.

History of Sawing Machinery — Classification (into Drag; Mulay (scroll and log); Jig Scroll; Single Frame (overhung, vertical gate); Gang Sash; Reciprocating Chain, Band, and Cylinder Saws; "Woodpecker"; Solid, Segmental, Inserted Toothed, and Side-Cutting Circulars; Wabble Circular; Convex and Concave Cutting Chain Saws; Dished and Spiral Saws; Solid Segmental, and Insertable Toothed Cylinder Saws; Perpendicular, Inclined, and Horizontal Band Saws); Comparison; Construction; Wood, Iron, and Compound Frames; Descriptions of various Machines, with Dimensions, Speeds, Capacities, and Power Required; Various Operations (Felling, Butting, Slabbing, Squaring, Ripping, Cross Cutting, and Edging; Lath, Shingle, and Picket Making; Grooving; Tenoning; Scroll Sawing; Desiderata in Sawing Machines; Instructions for Ordering; Cautions in Buying. Site of Saw Mills; Planning and Construction of Building; Generation of Power (Water Wheels, Engines, and Boilers); Transmission (Shafting, Pulleys, Hangers, Couplings, Gears, Pulleys and Belts, Friction Pulleys Wire Ropes, Journals, Bearings, and Lubrication). Waste by various widths of Kerf; Tables of Log Measurements for logs 10 to 20 feet long, and 12″ to 96″ diameter; Lumber Grading; Gauges and other Tables. Manufacture, Choice, Care, and Use of Blades; Filing; Gumming; Swaging; Setting. List of U. S. Patents on Sawing Machinery from 1790 to 1882. Hauling, Dogging, and Rossing the Logs. Insurance on Saw Mills. Cremating Sawdust and Slabs; making Compressed Fuel from Sawdust and Pitch. Distribution of the Timber Supply in the United States, Canada, and Europe; Characteristics of the various American and Foreign Woods.

The above work has been carefully prepared from the best American and European practice, and is believed to be the most complete as to details and practical information ever issued. It is so arranged and so thoroughly indexed that any subject can be readily found; and is up to date.

This work will be handsomely printed on heavy paper, and well bound in cloth; and will contain over two hundred illustrations, many of them full page. It will be a large quarto, so as to show the cuts in their full size.

Price to subscribers is fixed at **TEN DOLLARS**, and will be advanced after publication.

ROBERT GRIMSHAW,

930 Market Street, Philadelphia.

TJ
1233
G7
1882

Stanford University Libraries
Stanford, California

Return this book on or before date due.